

AN ILLUSTRATED KEY FOR THE GENERA OF
CERATOPOGONIDAE (DIPTERA) OF THE WORLD

By

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INTRODUCTION

Ceratopogonidae is a large family of minute flies, which was brought to the attention of taxonomists in 1852 by Winnertz in his monograph of the European species of the genus Ceratopogon. The contributions following Winnertz were those of Coquillett who published on American species from 1900 to 1905. He included all the species in Ceratopogon. Kieffer (1899-1926) described several species and erected many genera. Ceratopogonidae was recognized as a subfamily of Chironomidae until Malloch (1917) finally elevated them as belonging to a distinct family. Later Edwards (1926) published the diagnostic characters of many genera which are now being used as the basis for modern classification.

Since 1925 Macfie has been monographing groups on a worldwide basis.

The early publications on the genera of American ceratopogonids were published by Malloch (1915), Thomsen (1935, 1937), Hoffman (1924-1939), Root and Hoffman (1937) and Johannsen (1943). Recent ones are those of Wirth (1952, 1962a) and Wirth and Stone (1956).

The important papers on European Ceratopogonidae are those of Kieffer (1925), Edwards (1926), Goetghebuer (1920), Lindner (1934) and Claesrier (1961-).

Elsewhere, Lutz (1912-1914) and Lane (1944-1956) worked on the Neotropical genera, Carter, Ingram and Macfie (1920-1922),

on the West African, de Meillon (1931-) on the South African, Tokunaga (1939-) on the Japanese and the Micronesian (Tokunaga and Murachi, 1959), and Lee (1948-) and Skuse (1889) on the Australasian species.

A key to the genera of Ceratopogonidae was published in 1926 by Kieffer who separated the family into 59 genera. Other keys have been made by many authors who mainly limited their keys to the genera and the species in a certain region. Edwards (1926) published the diagnostic characters of the genera occurring in Great Britain. Johannsen (1932) constructed a key based on the collection from Malayan Subregion with the additional genera which were recorded from the entire Oriental region. Goetghebuer (1933) published a key for the genera of the Palearctic region.

Macfie's key (1940a) was considered to be the complete key to the known genera of that time. It was a concise key which contained 63 genera but he failed to give the generic definitions, which made the key ineffective to taxonomists. The best key to North and South American genera, Johannsen (1943), included the illustrations of many important generic characters. Lee (1948) published a key to the genera known to occur in the Australasian region. He divided the family into 10 groups, using Macfie's groupings (1940a). He also presented a comparison of closely related genera. A key to some American genera was published in 1952 by Wirth, based on his studies of California ceratopogonids. A key to the North American genera was also presented by Wirth and Stone (1956). Recent keys to the subfamilies, genera and subgenera of the Ceratopogonidae of the World by Wirth (1959c, unpublished) and the genera of the tribe Sphaerominae

(1962) are probably the most comprehensive ones. The latter provided some illustrations of the important characters and generic diagnoses were added.

There has been a great deal of discrepancy among the current keys because of the confusion which is almost always present with the key and the generic diagnosis. Many previously established genera were synonymized or sometimes reduced to subgeneric rank. It is very difficult to use available keys with this added confusion. Therefore a complete and comprehensive key is needed to facilitate the classification of ceratopogonids. An attempt is made in these studies to provide the diagnostic characters of each genus with detailed illustrations of its representative species. Whenever possible the type species was selected for study. Keys to the subgenera are also presented and the important references are provided.

The following genera: Dolichohelea, Acanthohelea, Luciomyia and Ceratobezzia are not included in the key for the genera of Ceratopogonidae. The specimens of these genera are not represented in the collection. The information obtained is only that published by the authors and the fragmentary information was summarized in this report.

The information on the immature stages, biology and habitats of any genus is included whenever it is available.

The specimens for this study were obtained from the U. S. National Museum.

KEY FOR THE GENERA OF CERATOPOGONIDAE

1. Female antenna 13-14-segmented 2
Female antenna 15-segmented 3
2. The r-m crossvein absent Leptoconops (Fig. 2)
The r-m crossvein present. Genus P (Fig. 98)
3. Female empodium large 4
Female empodium small or vestigial 5
4. Radial cells not well developed, first small or obliterated,
second small, wing with abundant flattened macrotrichia;
body densely covered with hairs; male genitalia: ninth
tergum short and tapered, setose apicolateral process
present Forcipomyia (Fig. 9)
Radial cells well developed, second one large, wing with
moderate stiff macrotrichia; body hairs sparse; male
genitalia: ninth tergum rounded, apicolateral process
absent Atrichopogon (Fig. 6)
5. Antennal segments sculptured Dasyhelea (Fig. 25)
Antennal segments not sculptured 6
6. Radial cells both absent 7
Radial cells present, at least one. 10

7. Palpi five-segmented Genus M (Fig. 95)
 Palpi two-four-segmented 8
8. Palpi four-segmented; wing not broad; male antenna
 14-segmented Paradasyhelea (Fig. 28)
 Palpi two-segmented; wing broad; male antenna
 eight-segmented 9
9. Posterior branch of media narrowly interrupted at base,
 cell M_4 large, costa extended about half of wing
 length Genus Q (Fig. 99)
 Posterior branch of media broadly interrupted,
 cell M_4 small, costa short extended about one-
 third of wing length Genus S (Fig. 101)
10. Media petiolate , usually forking behind r-m crossvein 11
 Media sessile, forking at or before r-m crossvein 24
11. Claws small, equal and simple in both sexes; one or two
 radial cells almost equal in size 12
 Claws of female usually large; one or two radial cells,
 second one always much longer than the first 14
12. Palpi five-segmented Culicoides (Fig. 29)
 Palpi three-four-segmented 13
13. Palpi three-segmented; one radial cell, lower branch of
 media absent; one spermatheca Genus N (Fig. 96)
 Palpi four-segmented; two medial cells, long and broad,
 lower branch of media present; two spermathecae
 Austroconops (Fig. 46)

14. Second radial cell not or little longer than the first,
 one or both cells may be obliterated (in Alluaudomyia
 first one usually obliterated) costa about half of
 wing length 15
 Second radial cell much longer than the first, costa
 extended to wing tip or two-thirds of wing length 17
15. Wing with one radial cell, usually with 1-20 small
 dark spots and sometimes with grayish streaks along
 the wing veins; two claws on each leg. Alluaudomyia (Fig. 50,51)
 Wing usually with two radial cells, usually without
 dark spots; one or two claws on each leg 16
16. All claws single, stout and slightly curved; palpi two-
 segmented; wing veins with only cubital stem and 1A
 present, Cu_1 indistinct, microtrichia spinelike
 Camptotroteroheslea (Fig. 47)
 Two claws on each leg, equal or subequal; palpi five-
 segmented; wing with lower branch of media often absent
 or interrupted, without microtrichia . . Ceratopogon (Fig. 48)
17. Costa extending beyond vein R_5 , one or two radial
 cells; claws usually equal 18
 Costa not extending beyond vein R_5 , two radial cells
 present, claws equal or unequal 20
18. Two radial cells, first one small; palpi three-
 segmented Genus 0 (Fig. 97)
 One radial cell, palpi four-segmented 19

19. First tarsomere of mid leg much longer than that of the
other legs and bearing spines; Coxae of male with
few hairs; male genitalia: aedeagus arched, paramere
absent Genus R (Fig. 100)
- First tarsomere of mid leg simple; coxae of male densely
covered with bristles; male genitalia: aedeagus large,
paramere small and fused to form a triangular sclerite
behind aedeagus Parabezzia (Fig. 60)
20. Hind femur simple, armed or unarmed, tibia not curved 21
Hind femur swollen in both sexes, armed ventrally with
numerous spines, tibia curved basally . . Serromyia (Fig. 58)
21. Female abdomen simple 22
Female abdomen highly modified with tenth segment curved
forward and reaching the ventral side of anterior
segments Macrurchelea (Fig. 59)
22. Male antenna plumose; femora and tibiae unarmed; last
antennal segment simple 23
Male antenna without plumes; almost all femora and
tibia armed with long spines; last antennal segment
usually shorter than the preceding four segments
. Echinochelea (Fig. 55)
23. Female claws all unequal; first tarsomere of mid leg
bearing subbasal spur; male genitalia: ninth tergite
rounded, aedeagus reduced to a pair of oblique lateral
sclerites, parameres with modified, well developed
submedian process Stilobezzia (Fig. 52)

- Female anterior four claws equal, hind claw with one long
and with or without another short one; male genitalia:
bilobed or truncate ninth tergum, aedeagus usually with
a pair of lateral sclerites and additional dorsomedian lobe,
parameres fused or paired Monohalea (Fig. 56)
24. Female fifth tarsomere with numerous ventral blunt
spines or batonnets 25
Female fifth tarsomere with or without sharp batonnets . . . 37
25. Female claws highly unequal; wing with two radial cells . . . 26
All female claws equal with internal or external basal
tooth; one or two radial cells 27
26. All female claws unequal; batonnets appear on basal half
of fifth tarsomere Xenohalea (Fig. 67)
Claws highly unequal only on four posterior legs, each
with external basal tooth; fifth tarsomere with numerous
batonnets along the segment Johannsenomyia (Fig. 66)
27. Female abdomen with ventral sclerotized plate on
seventh segment 28
Female abdomen without sclerotized plate on seventh segment . . 29
28. Wing with two radial cells; anterior part of thorax
cone-shaped Genus H (Fig. 91)
Wing with one radial cell; anterior part of thorax
rounded Genus K (Fig. 93)

29. Hind tarsus about three times longer than mid
 tarsus Calyptopogon (Fig. 70)
 Hind tarsus simple 30
30. Wing of female with usually broad anal lobe. Jenkinshelea (Fig. 68)
 Wing with anal lobe narrow and simple 31
31. Female claws each with internal basal tooth (Genus J:
 claws with internal tooth in one and external tooth
 in the other claw); ventral hair tufts absent 32
 Female claws each with external basal tooth; abdomen
 with ventral hair tufts 34
32. One spermatheca; anterior tubercle well developed
 Genus A (Fig. 82)
 Two spermathecae; anterior tubercle poorly developed
 or absent 33
33. One radial cell; claws each with internal tooth in one and
 external tooth in the other; leg unarmed . . Genus J (Fig. 92)
 Two radial cells; claws each with internal basal tooth;
 legs with numerous spines on ventral side of femora and
 bristles on dorsal side of tibiae . . . Sphaeromias (Fig. 71)
34. Legs armed with ventral spines on femora and dorsal spines
 on tibiae; male genitalia: highly modified, with basistyle
 poorly developed and fused to form a cone-shaped process
 Nilobezzia (Fig. 74)
 Leg with femora and tibiae unarmed 35

35. Wing with two radial cells Mallochohelea (Fig. 73)
 Wing with one radial cell 36
36. Costa very long reaching the wing tip; fourth tarsomere
 bilobed; spermatheca small; mandible without serrate
 margin; male genitalia: parameres fused mesally, tip
 slender and separated Probezia (Fig. 69)
 Costa short, not reaching the wing tip; fourth tarsomere
 oval; spermathecae large; mandible with serrate margin;
 male genitalia: parameres separated then fused again
 at the tip Genus T (Fig. 102)
37. Fifth tarsomere at least on one leg with one to five
 ventral sharp spines, or abdomen cone-shaped 38
 Fifth tarsomere without ventral sharp spines 44
38. Abdomen cone-shaped 39
 Abdomen simple, not cone-shaped 40
39. Fifth tarsomere with about three ventral spines on distal
 half; gland rods on seventh abdominal segment only
 Pachyhelea (Fig. 77)
 Fifth tarsomere without ventral sharp spines; gland rods
 present on segments five, six, and seven .Genus D (Fig. 85,86)
40. Female abdomen with gland rods 41
 Female abdomen without gland rods 43

41. Femora armed with ventral spines; first hind tarsomere
 longest Genus B (Fig. 83)
 Femora unarmed; first hind tarsomere simple 42
42. One radial cell; tarsal segments two to five rather short;
 all femora rather swollen Genus L (Fig. 94)
 Two radial cells; tarsal segments two to five simple;
 four anterior femora slender, hind femora enlarged
 Genus E (Fig. 87)
43. One spermatheca, large, pear-shaped; claws small; hind
 femora slender; fifth tarsomere stout with one to two
 sharp spines; two radial cells; mandible with five
 large teeth Genus G (Fig. 90)
 Two spermathecae; claws large especially of hind legs,
 each with inner basal tooth; hind femora enlarged and
 curved; fifth tarsomere slender, sometimes with spines;
 mandible with about 11 teeth Genus F (Fig. 88,89)
44. Hind tarsus of female about three or more times longer
 than midtarsus; claws highly unequal, single long hind
 claws with barb 45
 Hind tarsus of female simple; all claws equal, if unequal
 without any single claws 47
45. Femora of fore legs greatly swollen and armed ventrally with
 spines; fore tibiae arched along femora . Heteromyia (Fig. 63)
 Femora of fore legs simple; fore tibiae not arched 46

46. Fourth tarsomeres with bifid spinose lobes on fore and
mid legs but long and cylindrical on hind legs; fore
femora armed ventrally; abdomen petiolate; wing fasciate;
fifth tarsomere of fore leg simple . . . Tetrabezia (Fig. 62)
- Fourth tarsomeres cordiform to transverse on fore and
mid legs but elongated on hind legs; fore femora
unarmed; abdomen slightly curved downward; wing not
fasciate; fifth tarsomere of fore leg swollen
. Pellucidomyia (Fig. 64)
47. Fourth tarsomeres of at least four posterior legs
strongly bilobed and each lobe terminates in a
stout spine Clinohoelea (Fig. 61)
- Fourth tarsomeres cordate or cylindrical 48
48. Antennal segments with stiff hairs; radial cell narrow . . . 49
- Antennal segments without stiff hairs; radial cell simple . . 50
49. Vein M_2 elbowed in female; female antennal segments three
to ten with stiff hairs; palpi four-segmented; fourth
tarsomere spoon-shaped to subcylindrical; last three
tarsomeres simple; male genitalia: parameres fused with
broad rounded tip; two spermathecae . . . Stenoxenus (Fig. 75)
- Vein M_2 not elbowed; female antennal segments 11-15 with
stiff hairs; palpi five-segmented; fourth tarsomere cordate
to subcylindrical; last three tarsomeres relatively short;
male genitalia: parameres separated; one spermatheca
. Paryphoconus (Fig. 76)

50. Costa extended beyond R_5 ; two radial cells; femora
 unarmed Neurohelea (Fig. 65)
 Costa not extended beyond R_5 ; one or two radial cells;
 femora usually armed, at least on one leg 51
51. One radial cell 52
 Two radial cell 53
52. Male genitalia: basistyle and dististyle reduced but
 distinctly separated Phaenobezzia (Fig. 81)
 Male genitalia: basistyle and dististyle well developed
 Bezzia (Fig. 79)
53. Hind claws longer than the claws on the first four legs;
 fourth tarsomere oval to elongated; gland rods
 absent Genus C (Fig. 84)
 All claws equal; fourth tarsomere bilobed or cordiform;
 gland rods always present Palponyia (Fig. 78)

DESCRIPTIONS

Genus Leptoconops Skuse

Leptoconops Skuse, 1890, Proc. Linn. Soc. N. S. Wales, 4:288;

Johannsen, 1905, Bull. N. Y. State Mus., 86:94; Kieffer, 1906, Gen. Insectorum, fasc. 42:48; 1908, Ann. Mus. Nat. Hung., 6:577; 1921, Arch. Inst. Pasteur Afr. Nord, 1:107; Carter, 1921, Bull. Ent. Res., 12:1; Johannsen, 1943, Ann. Ent. Soc. Amer., 36:777; Lee, 1948, Proc. Linn. Soc., N. W. W. 72:332-8; Wirth, 1952, Univ. Calif. Publs. Ent., 9:109; Smee, 1966, Aust. J. Zool., 14:993; Chanthawanich and Delfinado, 1967, J. Med. Ent., 4:294 (Type-species: Leptoconops stygius Skuse, Mon).

Tersesthes Townsend, 1893, Psyche, 6:370 (Type-species: Tersesthes torrens Townsend, mon.).

Centrotypus Grassi, 1901, Studi di Zool. sulla Mal. Roma, p. 118
(nomen nudum).

Mycterotypus Noe, 1905, Rend. atti Accad. Lincei, 14:114 (Type-species: Mycterotypus bezzii Noe, desig. Carter, 1921).

Mycteromyia Lutz, 1912 (not Philippi, 1865), Mem. Inst. Oswaldo Cruz, 4:24 (lapsus for Mycterotypus Noe).

Holoconops Kieffer, 1918, Ann. Mus. Nat. Hung., 16:135 (Type-species: Leptoconops kerteszi Kieffer, orig. desig.).

Schizoconops Kieffer, 1918, Ann. Mus. Nat. Hung., 16:135 (Type-species:

Schizoconops indicus Kieffer, orig. desig.).

Styloconops Kieffer, 1921, Arch. Inst. Pasteur Afr. Nord, 1:107

(Type-species: Leptoconops albiventris de Meijere, orig. desig.).

Protersesthes Kieffer, 1921, Arch. Inst. Pasteur Afr. Nord, 1:107

(Type-species: Tersesthes brasiliensis Lutz, orig. desig.).

Microconops Kieffer, 1921, Arch. Inst. Pasteur Afr. Nord, 1:108

(Type species: Microconops vexans Kieffer, orig. desig.).

Acanthoconops Carter, 1921, Bull. Ent. Res., 12:24 (Type-species:

Acanthoconops spinosifrons Carter, orig. desig.).

- DIAGNOSIS. Eyes bare, widely separated in both sexes; vertex with bristles; frons and clypeus bare or hairy. Mandible about 16 teeth. Palpi "four-segmented"; distal two segments fused; male palpi longer than in female. Female antennae 13- or 14-segmented, the flagella segments subspherical or oval, each with few hairs and transparent sensory spines, the terminal segment elongate. Male antennae 15-segmented, plumose. Thorax arched anteriorly; humeral pits present. Wings usually milky white; R separate at base, fused with costa about mid wing forming a stigma; crossvein absent; intercalary vein above vein M_1 conspicuous. Legs slender, hind legs longest; femora unarmed, tibiae each with stout apical spur; hind tibial comb five to seven; basitarsus with prominent ventral spines. Tarsal claws with small bristle or toothed; empodium small and branched. Abdomen with ninth segment bearing long or short lamellae or cerci, two well developed spermathecae. Male genitalia conspicuous; basistyles

with subbasal ventromesal lobe; dististyles short, small and tapering; aedeagus simple; parameres usually stout, heavily sclerotized.

Approximately 62 species have been described.

Distribution: World-wide.

Keys to the larval and pupal stages of North American species are presented by Wirth and Stone (1956) and Thomsen (1937). The immature stages of the Bodega black gnat were described in detail by Smith and Lowe (1948).

EGG. The egg is unsculptured, usually banana-shaped, blunt at one end and narrower at the other, slightly curved and circular in cross section.

LARVA. The head is partly sclerotized, inside the head and first thoracic region is a system of heavily chitinized rods connected with the mandibular processes. Labrum scoop-like. Antennae at the extreme tip of the head are protrusible. Abdominal segments each with an intercalary segment, giving the appearance of 23 segments in larva.

PUPA. Respiratory tube two-segmented, bearing 15 spiracles apically. The head is rugose. Abdominal segments covered with sharp recurved spines, located on large tubercles. Last segment is forked, without spines or tubercles.

Adult habits and larval habitats: adult feeds on vertebrate blood, female may feed only once or as many as four times, males do not feed. Carter (1921) states that the adults are most active during the hottest parts of the day. Larvae are found in damp soil and along the seacoast in sand with organic matter.

The genus Leptoconops was erected by Skuse in 1889 for Leptoconops styrius Skuse. In 1893, Townsend set up the new genus Tersesthes and Noe (1905) proposed the genus Mycterotypus, which are now placed as

synonyms of Leptoconops. In 1918 and 1921 the genus was divided into five new genera by Kieffer, these were: Holoconops, Schizoconops, Styloconops, Proteresethes and Microconops. Carter (1921) retained only the genus Leptoconops, with two subgenera, Leptoconops s.s. and Holoconops, and also erecting a new genus, Acanthoconops. Acanthoconops was synonymized under Styloconops Kieffer by Kieffer (1921a) and it was reduced to a subgenus by Wirth (1952). Three subgenera of Leptoconops are retained: Leptoconops, Holoconops and Styloconops.

This genus is different from most of the ceratopogonids and readily recognized by the following characters: Palpus four-segmented. Antennae of female with 13 or 14 segments. Wings milky white; cross-vein r-m absent; intercalary vein above vein M, prominent. Legs, basitarsi usually armed with ventral spines. Lamellae or cerci of female usually prominent. Male genitalia, basistyle with subbasal lobe; dististyle with terminal appendage.

Subgenus Leptoconops s. str.

Subgenus type: Leptoconops stygius Skuse, mon.

Distinguished from the others by having toothed tarsal claws; sensory area of the third palpal segment large occupying almost the entire length. Female antennae 14-segmented. The lamellae of female long slender.

Illustration: Fig. 2 Leptoconops (Leptoconops) stygius Skuse.

Subgenus Holoconops Kieffer, 1918

Subgenus type: Leptoconops kerteszi Kieffer, orig. des.

This subgenus is characterized by having simple tarsal claws and subapical pit on third palpal segment. Female antennae 13-segmented. Female genitalia with moderately long, broad lamellae. Male genitalia with large, sclerotized parameres having lateral projections; dististyle bifid.

Illustration: Fig. 3 Leptoconops (Holoconops) kerteszi K.

Subgenus Styloconops Kieffer, 1921

Subgenus type: Leptoconops albiventris de Meijere, orig. des.

This subgenus is distinguished from the others by the following characters: Head with numerous spines or short bristles on frons and vertex; female antennae 14-segmented; palpus with sensory pit centrally or subbasally located. Tarsal claws with small basal tooth. Female genitalia with very short lamellae; parameres of male varied; the aedeagus fairly large.

Illustrations: Fig. 4 Leptoconops (Styloconops) albiventris (Meijere) and Fig. 5 Leptoconops (Styloconops) spinosifrons Carter.

Key for the Subgenera of Leptoconops

1. Female antenna with 13 segments Holoconops (Fig. 3)
 Female antenna with 14 segments 2
2. Female genitalia with lamella very long and slender; head
 with frons bare, few bristles on vertex; palpal sensory
 area occupying almost entire length of the third
 segment (Fig. 2B) Leptoconops (Fig. 2)
 Female genitalia with lamella very short (Fig. 5H);
 frons and vertex with numerous spines or short
 bristles (Fig. 4C, 5C); palpus with sensory pit subbasally
 or centrally located (Fig. 4A, 5A) . . . Styloconops (Fig. 4,5)

Genus Atrichopogon Kieffer

Atrichopogon Kieffer, 1906, Ann. Soc. Sci. Brux., 30: ?; 1906,

Gen. Insectorum, fasc. 42:53; Coquillett, 1910, Proc. U. S. Nat. Mus., 37:512; Kieffer, 1913, Rec. Ind. Mus., 9:174; 1919, Bull. Soc. Ent. France, p. 193; 1919, Ann. Mus. Nat. Hung., 17:20; Goetghebuer, 1920, Mem. Mus. Roy. Hist. Nat. Belg., 8:29; Carter, Ingram, and Macfie, 1921, Ann. Trop. Med. & Parasit., 15:321; Kieffer, 1924, Arch. Inst. Pasteur d' Algerie, 2:396; 1924, Bull. Soc. R. Ent. Egypte, p. 248; 1925, Faune de France, fasc. 11, p. 51; Edwards, 1926, Trans. Ent. Soc. London, 74:399; Johannsen, 1931, Arch. f. Hydrobiol., 9:414; Ingram and Macfie, 1931, Dipt. Pat. & S. Chile, pt. 2, fasc. 4, p. 172; Macfie, 1932, Ann. Trop. Med. Parasit., 26:31; 1934, Ann. Trop. Med. & Parasit., 28:184; 1939, Rev. Ent., 10:173; Tokunaga, 1940, Tenthredo, 3:109; Macfie, 1940, Ann. Trop. Med. & Parasit., 34:15; Zilahi-Sebess, 1940, Folia. Ent. Hungar. 5:34; Johannsen, 1943, Ann. Ent. Soc. Amer., 36:775; Macfie, 1947, Proc. R. Ent. Soc. Lon. (B), 16:72; Wirth, 1956, Proc. Ent. Soc. Wash., 58:16; Ewen and Saunders, 1958, Canad. J. Zool., 36:719; Tokunaga, 1959, Pacif. Ins., 1:179; Tokunaga and Murachi, 1959, Ins. Micron., 12(3):116; Remm, 1959, Ent. Obozr., 38:683; Remm, 1961, Ent. Obozr., 40:925; Tokunaga, 1962, Pacif. Ins., 4:154. (Type-species: Ceratopogon levis Coquillett as exiles Coquillett, by desig. Coquillett, 1910).

Didymophleps Weyenbergh, 1863, Stett. Ent. Zeit., 44:108 (Type-species: Didymophleps hortorum Weyenbergh, mon.).

Kempia Kieffer, 1913, Rec. Ind. Mus., 9:162 (As subgenus of Dasyhelea)

(Type-species: Dasyhelea (Kempia) calcuttensis Kieffer, by ?
desig.).

Gymnohelea Kieffer, 1921, Arch. Inst. Pasteur Afr. Nord, 1:115

(Type-species: ?).

Lophomyidium Cordero, 1929, An. Mus. Hist. Nat. Montevideo, 3:94

(Type-species: Lophomyidium uruguayense Cordero, mon.).

Psilokempia Enderlein, Tierwelt Mitteleur., 6(XVI):49 (Type-species:

Kempia appendiculata Goetghebuer, mon.).

DIAGNOSIS. Body stout, moderately hairy. Eyes pubescent or bare. Antennae 15-segmented, segments 4-10 globular or transverse, last five segments elongate, usually last segment terminates with nipple or style. Mesonotum bare or with few hairs. Legs slender; fore femora setose anteriorly. Wings moderately covered with macrotrichia, finer than in Forcipomyia and always lesser in male; costa long, about two-thirds of wing length, second radial cell well developed; intercalary fork distinct; median fork with short stem. Female abdomen usually bearing abdominal armature on sixth or seventh ster-al processes absent; aedeagus large, usually trilobed; parameres small, usually hook-shaped, or absent.

Approximately 296 species have been described.

Distribution: World-wide.

The biology and immature stages of Atrichopogon were studied by Johannsen (1952) and Ewen and Saunders (1958). The life history and

all stages of Atrichopogon levis were described in Boesel and Snyder (1944). Keys were provided by Thomsen (1937) and Wirth and Stone (1956) for North American species.

EGG. Atrichopogon levis egg is smooth, subshining, black; elongate and slightly curved. Most of the species lay eggs in masses, in aquatic situations.

LARVA. Body usually appears flattened as the sides of the segments often protrude into lateral processes. Head hypognathous, antennae spur-like. Head capsule commonly bears eleven pairs of setae; abdominal segments one to seven with six pairs of setae which is similar to metathorax. The mesothorax has two lateral setae and three on the prothorax. Prothorax with bilobed, pseudopod bearing backward-curved hooklets arranged in two transverse rows. The ninth abdominal segment is cylindrical, covered dorsally by an unpaired sclerite. Posterior segment with a pair of protrusible anal papillae and the anal pseudopod.

PUPA. Body broad anteriorly and tapering posteriorly. Respiratory horn variable in shape, appearing boot-shaped, flattened, or cylindrical. Thorax with six pairs of cuticular processes on the dorsal side. Posterior median point of mesothorax never overlaps the first abdominal segment. Abdomen with branched or setaceous projections on first five segments. Segment nine terminates with a pair of diverging and tapering processes and covered with small stout spinules directed forward. Male genital sheaths are ventral and protrusible.

Adult habits and larval habitats: Adult habits of Atrichopogon levis are given by Boesel and Snyder (1944). Males and females have been found flying in broad daylight above moist mud covered with algae.

Some were collected along streams and stagnant water. The species is abundant in the short grasses of parks, lawns or roadsides. Males usually swarm during sunset or other times of equivalent light. Larvae occur chiefly in shaded localities where mold, bacteria and algae are present in areas along the streams covering with algae, or wood and soil covering with moss. Most species are aquatic.

The adults of this genus are difficult to identify or even to separate distinctly into subgenera. As pointed out by Edwards (1926), Macfie (1939c), Nielsen (1951) and Wirth (1952, 1956), the adults offer no good, clear-cut character or combination of characters. The male genitalia might be very useful if there were no variation in appearance caused by protrusion or retraction. The form of the ventral armature of the female abdomen and the spermathecae might make a more satisfactory key, if an intensive study was made of the above characters.

Ewen and Saunders (1958) based their taxonomy mostly on the immature stages, which show excellent and accurate separations.

Atrichopogon is a well defined genus. It resembles Forcipomyia by having a large empodium, but can be distinguished from Forcipomyia adults by the following characters: second radial cell long, macrotrichia few or absent, microtrichia conspicuous and the nature of the fringe on the posterior margin of wing.

Subgenus Atrichopogon s. str.

Proboscis normal, straight. Eyes separated. Female antenna, segments 3-10 oval, segments 11-15 cylindrical and elongated. Spermatheca one.

Illustration: Fig. 6 Atrichopogon (Atrichopogon) levis (Coq.)

Subgenus Psilokempia Enderlein, 1936

Subgenus type: Kemoia appendiculata End. (orig. desig.)

Enderlein (1936) erected genus Psilokempia for Kemoia appendiculata End. It was reduced to subgenus by Remm (1959).

This subgenus is distinguished from the others by the following points: proboscis not curved, antennae with last five segments together about as long as segments 3-10 combined, palpi stout; macrotrichia of wing few or absent; one spermatheca; does not parasitize insects.

Illustration: Fig. 7 Atrichopogon (Psilokempia) arcticus (Coq)

Subgenus Meloehalea Wirth, 1956

Subgenus type: Atrichopogon meloesugans Kieffer (orig. desig.)

Wirth (1956c) erected this subgenus based on specimens that attack the beetles of family Meloidae. This group is characterized by having an unusually upcurved proboscis, palpi slender, antennae segments 11-15 together about twice as long as segments 3-10 combined; two spermathecae; macrotrichia abundant on wing; hind basitarsus about 2.5 times as long as the second segment.

Illustration: Fig. 8 Atrichopogon (Meloehalea) meloesugans K.

Key for the Subgenera of Atrichopogon

1. Proboscis upcurved; two spermathecae (Fig. 8L). Meloehelea (Fig. 8)
 Proboscis straight; one spermatheca 2

2. Antennal segments 3-10 rounded, 11-15 subspherical (Fig. 7A);
 female palpi with short segments (Fig. 7C); eyes contiguous
 (Fig. 7F). Psilokempia (Fig. 7)

- Antennal segments 3-10 oval, 11-15 cylindrical and elongated
 (Fig. 6A); female palpi with slender segments (Fig. 6C);
 eyes separated (Fig. 6F) Atrichopogon (Fig. 6)

Genus Forcipomyia Meigen

Forcipomyia (Megerle MS) Meigen, 1818, Syst. Besch. Eur. Zweifl.

Ins., 1:59; Kieffer, 1906, Gen. Insectorum, fasc. 42:52; 1913, Rec. Ind. Mus., 9:166; Malloch, 1915, Bull. Ill. State Lab. Nat. Hist., 10:311; Ingram and Macfie, 1924, Ann. Trop. Med. & Parasit., 18:541; Edwards, 1926, Trans. Ent. Soc. London, 74:393; Johannsen, 1931, Arch. f. Hydrobiol., 9:407; Ingram and Macfie, 1931, Dipt. Pat. & S. Chile, pt. 2, fasc. 4, pp. 156, 177; Macfie, 1932, Tijdschr. Ent., 75:279; 1934, Ann. Trop. Med. & Parasit., 28:178; Goetghebuer, 1935, Rev. Zool. Bot. Afr., 27:145; Macfie, 1939, Rev. Ent., 10:142; 1940, Ann. Trop. Med. & Parasit., 34:16; Tokunaga, 1940, Tenthredo, 3:61; Zilahi-Sebess, 1940, Folia. Ent. Hungar. 5:21; Johannsen, 1943, Ann. Ent. Soc. Amer., 36:777; Harant and Huttel W. & N., 1951, Ann. Parasit. Hum. Comp., 26:471; Saunders, 1956, Canad. J. Zool., 34:657; Tokunaga and Murachi, 1959, Ins. Micron., 12 (3):144; Tokunaga, 1959, Pacif. Ins., 1:256; Dessart, 1961, Bull. Ann. Soc. R. Ent. Belg., 97:315; Remm, 1962, Loodusuur. Seltsi Aastar., 54:168; Tokunaga, 1962, Pacif. Ins., 4:169; Dessart, 1963, Mem. Inst. Sci. Nat. Belg. (2) fasc. 71:13. (Type-species: Ceratopogon ambiguus Meigen = Tipula bipunctata Linnaeus by desig. Coquillett, 1910)

Tipula (part) Linnaeus, 1767, Syst. Nat., ed. 12, 2:978.

Ceratopogon (part) Meigen, 1804, Klass., 1:31.

Labidomyia Stephens, 1829, Cat. Brit. Ins., 2:239 (Type-species:

Tipula bipunctata Linnaeus, by desig. Westwood, 1840).

Tetrachora Philippi, 1865, Verh. Zool.-Bot. Ges. Wien, 15:630 (Type-species: Tetrachora fusca Philippi, mon.).

Prohelea Kieffer, 1912, Spolia Zeylanica, 8:1 (Type-species: ?).

Euforcipomyia Malloch, 1915, Bull. Ill. State Lab. Nat. Hist., 11:312
(Type-species: Euforcipomyia hirtipennis Malloch, by orig. desig.)

Lepidohelea Kieffer, 1917, Ann. Mus. Nat. Hung., 15:364 (Type-species: Ceratopogon chrysolophus Kieffer, mon.).

Microhelea Kieffer, 1917, Ann. Mus. Nat. Hung., 15:364 (Type-species: Atrichopogon tropicus Kieffer, mon.).

Apelma Kieffer, 1919 (not Billberg, 1820), Ann. Mus. Nat. Hung.,
17:64 (Type-species: Apelma auronitens Kieffer, ? desig. by
Macfie, 1940).

Trichhelea Goetghebuer, 1920, Mem. Mus. Roy. Hist. Nat. Belg., 8:18
(Type-species: Trichhelea tonnoiri Goetghebuer, mon.).

Thyridomyia Saunders, 1925, Parasit., 17:268 (Type-species: Thyridomyia palustris Saunders, orig. desig.).

Phasmidohelea Mayer, 1937, Arb. Morph. Tax. Ent. Berlin-Dahlem,
4:233 (Type-species: Phasmidohelea crudelis Mayer, orig. desig.).

DIAGNOSIS: Body stout, densely covered with hairs. Eyes bare.

Antennae 15-segmented, segments 3-10 pear-shaped to vase-shaped in female, with dense verticils, segments 11-15 usually cylindrical to elongate, last segment often ending in a nipple; in male, segments 12-14 swollen at base, segment 12 very long, and segments 12-15 each with a single verticil. Humeral pits absent, mesonotum densely covered with hair and a few bristles. All legs and abdomen, especially

in male, with long bristles; femora large, empodium well developed, usually as long as claws (absent in male of Apelma = Trichohelea). Wings with flattened macrotrichia abundant; costa ending about the middle of wing; first radial cell small or almost obliterated, second cell small but distinct; intercalary fork present; median fork with short stem, usually faint. Male genitalia not inverted; aedeagus large, shield-shaped; parameres usually present, slender and tapering, often fused at base or connected by transverse rod or plate.

Approximately 507 species have been described.

Distribution: World-wide.

Biology and early stages of Forcipomyia have been studied in detail by quite a number of taxonomists. In 1923, Frew described the larval and pupal stage of F. piceus; Saunders (1924, 1925) published the most extensive papers on the immature stages of Apelma and Thyridomyia; de Meillon (1931) on one species from Transvaal; Mayer (1933) on F. comis; Tokunaga (1934) on F. crummei; Lane (1947a) on F. argenteola and F. inornatipennis. Saunders (1956) had done the most extensive study in distinguishing the subgenera of Forcipomyia using characters of all stages. Recent papers on the immature stages and biology of Forcipomyia were published by Saunders (1959) on some species of Proforcipomyia and Thyridomyia, Saunders (1963) on subgenus Lasiohelea; Chan and Saunders (1965) on F. (Dacnoforcipomyia) anabaenae; and Chan and Le Roux (1965) on F. (Neoforcipomyia) eques and F. saundersi. Keys to early stages of North American species were presented by Thomsen (1937) and Wirth and Stone (1956).

EGG. Mayer (1934) stated that eggs of F. picea are found in irregular masses and those of F. pallida in garlands.

LARVA. The larvae of this genus exhibit a considerable range of variation of structure throughout the subgenera. Most of them have elongate body, distinctly segmented, each segment as long as wide and bearing either dome-shaped projections ending in hooks, or spear-shaped, or fringed setae. Head hypognathous; they have eversible prothoracic and anal pseudopods.

PUPA. The pupa are less variable and may be confused with Atrichopogon. The posterior three segments remain tightly attached to the larval exuviae. Respiratory trumpets short, knob-like, bearing spiracles only at apex.

Adult habits and larval habitats: Saunders (1959) found many species of the subgenera Proforcipomyia and Thyridomyia as pollinators of cacao. Chan and Saunders (1965) stated that F. (D.) anabaenae females are diurnal man-biters, preferring the shaded parts of the body. The females of Pterobosca group have specialized habit as ectoparasite of dragonflies. Females of eques (Johannsen) and related species suck the blood from the wing veins of lacewing flies, butterflies and other insects (Wirth and Stone, 1956). Larvae are mostly terrestrial, the gregarious larvae breeding under tree bark, in manure or moist decaying vegetable matter, in ant nests, and the like. F. calcarata (Coquillett) larvae were found along the rocky margin of a warm mineral spring at Alum Rocky Park in Santa Clara County, California (Wirth, 1952).

This genus is very large and shows a wide range of variation among the species. Many attempts have been made to subdivide the genus into subgenera. Saunders' system seems to be the most acceptable. He set up eight subgenera based on larval and pupal characters in addition to adult characters (Saunders, 1956). Tokunaga and Murachi (1959) mentioned using the following main characters to separate the subgenera: structure of male hypopygium; number of spermathecae; development of female antennae; value of hind tarsal ratio; segmentation of maxillary palp; wing venation, and development of scales and colored markings.

Members of this genus are readily recognized by having abundant macrotrichia on wing, radial cells very small and empodium well developed as long as claws.

Subgenus Forcipomyia, s. str.

It is characterized by having two spermathecae; palpi usually five-segmented, third segmented with distinct sensory pit. Female antennal segments 3-10 flask-shaped, not compressed. Wing with dense macrotrichia, costa short, first radial cell small or absent, second one short. Male genitalia with parameres separated, pointed tip; aedeagus shield-shape, rather variable.

Illustration: Fig. 9 Forcipomyia (Forcipomyia) bipunctata (L.)

Subgenus Proforcipomyia Saunders, 1956

Subgenus type: Forcipomyia wirthi Saunders (orig. desig.)

Saunders (1956) proposed the new subgenus Proforcipomyia with wirthi Saunders as type, to substitute for the uncertain identification

of hirtipennis of subgenus Euforcipomyia Malloch 1915. Since Malloch's subgenus had been placed in miscellaneous species by Johannsen, also Wirth misplaced the species calcarata (Coquillett) in this subgenus.

Members of this subgenus can be differentiated from the others by the following characters: wing densely covered with slender macrotrichia; costa about half of wing length; palpi five-segmented, sometimes the last two segments incompletely fused; first and second radial cells small or absent; spermathecae two. Male genitalia: parameres U- or V-shaped, arched, arising from basistylar apodemes; aedeagus shield-shaped.

Illustration: Fig. 10 Forcipomyia (Proforcipomyia) wirthi Saunders.

Subgenus Warmkea Saunders, 1956

Subgenus type: Forcipomyia bicolor Saunders (orig. desig.)

Saunders (1956) believed this new subgenus to be a "young" offshoot from the parent stock of the subgenus Forcipomyia and that it had not had time to evolve any great variety of species. Larval habitat is very uniform, all species but one have been found breeding in the leaf axils of water-holding plants in the Caribbean area. The larvae live above the water line and moved further up to pupate. The pupa has the best specific characters. The pupa cements itself to the leaf surface by the penultimate segment. The larval exuviae can usually be found stretched out on the leaf a few millimeters behind the pupa.

The distinctive characters of this subgenus are: female antenna long, segments 3-10 with hyaline sensory hairs, segment 11 rather short; wing with thin microtrichia, second radial cell long. One spermatheca.

Male genitalia: parameres with hooked tips.

Illustrations: Fig. 11 Forcipomyia (Warmkea) aeria Saunders and

Fig. 12 Forcipomyia (Warmkea) tuberculata Saunders.

Subgenus Caloformipomyia Saunders, 1956

Subgenus type: Forcipomyia caerulea Saunders (orig. desig.)

This subgenus is represented by two species from Brazil (Saunders, 1956). The larvae have subcutaneous green or blue pigment granules in the fat body. Female antenna with hyaline sensory hairs. Segment 11 of the male antenna longest. Wing with elongated second radical cell. Male genitalia: parameres V-shaped; ninth sternite transverse.

Illustration: Fig. 13 Forcipomyia (Caloformipomyia) glauca Edwards

Subgenus Metaformipomyia Saunders, 1956

Subgenus type: Forcipomyia cerifera Saunders (orig. desig.)

A Brazilian species, cerifera Saunders was designated as a type of the subgenus (Saunders, 1956). The characteristics which differentiate it from other subgenera are: female antennae with basal segments flask-shaped, each with a hyaline hair; two spermathecae; male genitalia: parameres fused, basistylar apodemes curved and joined; larvae bearing wax-covered globules of liquid.

Illustrations: Fig. 14 Forcipomyia (Metaformipomyia) pluvialis Malloch.

Subgenus Thyridomyia Saunders, 1925

Subgenus type: Thyridomyia palustris Saunders (orig. desig.)

It is characterized by having the basal antennal segments compressed in female; macrotrichia of wing not flattened, second radial cell subtriangular in female; one spermatheca; male genitalia with complicated aedeagus, lateral sclerites chitinized; parameres forming a pair of subtriangular internal plates reduced to small slender sclerites of well developed and connected caudal external lobes absent.

Illustration: Fig. 15 Forcipomyia (Thyridomyia) palustris Saunders.

Subgenus Synthyridomyia Saunders, 1956

Subgenus type: Lasiohelea acidicola Tokunaga (orig. desig.)

Members of this subgenus share the common characteristic of male genitalia with club-shaped parameres extending backward from variously shaped basal roots. Larva with well developed antennal flagellum. Body usually without scales. Spermatheca one.

Illustration: Fig. 16 Forcipomyia (Synthyridomyia) colemani

Subgenus Trichohalea Goetghebuer, 1921

Trichohalea was adopted to replace Kieffer's genus Apelma, which was occupied previously by a genus of beetles. The important characteristics of this group are: empodium of male absent or vestigial. Wing with long second radial cell, thinly covered with macrotrichia. Male genitalia: parameres H-shaped with cross bar between bases of coxites and paired forward apodemal projections and backward external caudal lobes arising from bases of coxites; aedeagus large and shield-shaped.

Illustration: Fig. 17 Forcipomyia (Trichohalea) fijiensis (Macfie)

Subgenus Lasiohelea Kieffer, 1921

Subgenus type: Atrichopogon pilosipennis Kieffer (orig. desig.) = velox (Winnertz)

Tokunaga (1959) reduced Lasiohelea to a subgenus of Forcipomyia.

The following characteristics differentiate this subgenus from the others: wing with distinct bare areas adjoining veins, second radial cell long and very narrow; male genitalia with aedeagus subdivided into a pair of recurved sclerites, each bearing apical hook-like process; paramere simple, arch-like.

Illustration: Fig. 18 Forcipomyia (Lasiohelea) fairfaxensis Wirth

Subgenus Neoforcipomyia Tokunaga & Murachi, 1959

Subgenus type: Forcipomyia pectinunguis de Meijere (Tokunaga & Murachi, 1959:200-202)

This subgenus was erected by Tokunaga (1959) for species which are closely related to Lasiohelea but the male genitalia have arch-like parameres and spoon-shaped caudal lobes arising from coxite joints, coxites at lateral ends of paramere arms. The other characters are: basal antennal segment subspherical, distal segments elongated; wing densely covered with slender macrotrichia; two spermathecae.

Illustration: Fig. 19 Forcipomyia (Neoforcipomyia) eques (Joh.)

Subgenus Dacnoforcipomyia Chan and Saunders, 1965

Subgenus type: Forcipomyia anabaenae C. & S. (Orig. desig.)

Chan and Saunders (1965) erected this subgenus based on the larval stages and the male. Members of this subgenus are characterized by the following points: larval head with one pair of small,

sharp, forward-pointed prominences on vertex; antennae short, stout; prothoracic pseudopod long, armed distally with two stout black hooks; anal pseudopod with only six stout black hooks; cauda short, rounded. Female antenna with basal five segments compressed, each with a pair of hyaline setae. One spermatheca. Male genitalia: basistyles slender; dististyles straight, uptapered, equal in length to basistyles, basistylar apodemes joined; parameres absent; aedeagus with two parts.

Illustration: Fig. 20 Forcipomyia (Dacnoforcipomyia) anabaenae

Chan and Saunders

Subgenus Phasmidohelea Mayer, 1937

Subgenus type: Phasmidohelea crudelis Mayer (orig. desig.)

Mayer (1937) proposed the genus Phasmidohelea for the three species which attack phasmids. Wirth (1956c) reduced to subgenus of Forcipomyia based on the following characters which resembles Forcipomyia: palpi with third segment swollen to apex; basitarsus short with strong spines; empodium large; two spermathecae. They are differentiated from the other subgenera by having a tick-like abdomen in female and mouthparts short, stout and highly sclerotized.

Illustrations: Fig. 21 Forcipomyia (Phasmidohelea) fuliginosa Mg.

and Fig. 22 Forcipomyia (Phasmidohelea) sp.

Subgenus Lepidohelea Kieffer, 1917

Subgenus type: Ceratopogon chrysolophus K. (orig. desig.)

Members of this subgenus are characterized by having four-segmented palpi; two spermathecae; male genitalia with parameres

separated; hind tibial comb present.

Illustration: Fig. 23 Forcipomyia (Lepidohalea) annulatifera Macfie

Subgenus Pterobosca Macfie, 1932

Subgenus type: Ceratopogon aeschnosuga Meijere (Macfie 1940 a:16)

It differs from subgenus Forcipomyia by having six elongated terminal antennal segments; empodium of female large and broad, adapted for clinging; wing with moderate macrotrichia but without scale-like hairs; spermatheca one or two.

Illustration: Fig. 24 Forcipomyia (Pterobosca) fusicornis (Coq.)

Key for the Subgenera of Forcipomyia

1. Antennae with last six segments elongated (Fig. 24A);
 legs with empodium very broad, modified for clinging
 (Fig. 24H) (female mainly ectoparasite on Odonata or
 rarely on lacewing flies) Pterobosca (Fig. 24)
- Antennae with last five segments elongated; empodium
 large but normal 2
2. Two spermathecae 3
 One spermatheca 9
3. Last five segments of antenna combined not longer than the
 preceding eight segments combined 4
 Last five segments of antenna combined much longer than the
 preceding eight segments combined 6
4. Sensory pit deep (Fig. 9C); antenna with segments almost
 similar in shape and size (Fig. 9A) . . . Forcipomyia (Fig. 9)
- Sensoria scattering, without distinct pit; antenna with
 last five segments long, each segment more than three
 times longer than wide 5
5. First tarsomere short or about the same size as the second
 segment (Fig. 14G); palpi four-segmented (Fig. 14C);
 male parameres fused midline, truncate anteriorly
 (Fig. 14K) Metaforcipomyia (Fig. 14)
- First tarsomere longer than the second segment (Fig. 13J);
 palpi five-segmented (Fig. 13C, D); male parameres V-shaped,
 fused in the middle (Fig. 13M) . . . Caloforcipomyia (Fig. 13)

6. Basitarsus very short about half the size of the second
segment (Fig. 21K, 22G) Phasmidohelea (Fig. 21,22)
Basitarsus simple, not shorter than the second segment 7
7. Antennal segments 3-10 oval to flask-shape (Fig. 10A)
. Proforcipomyia (Fig. 10)
Antennal segments 3-10 depressed to transverse 8
8. Antennal segments three to seven depressed, 8-10 slightly
rounded (Fig. 17A); parameres H-shaped with cross bar and
paired forward apodemal projections and backward external
caudal lobes (Fig. 17•0) Trichohelea (Fig. 17)
Antennal segments 3-10 slightly transverse to oval (Fig. 19A);
parameres fused arch-like, arising from joint of basi-
styles (Fig. 19•0) Neoforcipomyia (Fig. 19)
9. Palpi four-segmented 10
Palpi five-segmented 11
10. Parameres separated (Fig. 23•0); antennal segments similar
in size and flask-shaped (Fig. 23A) Lepidohelea (Fig. 23)
Parameres fused basally (Fig. 12D); antenna with last five
segments very long about four times as long as broad, seg-
ments 3-10 oval (Fig. 11A) Warmkea (Fig. 11,12)
11. Last five antennal segments combined not longer than all
the preceding eight segments combined 12
Last five antennal segments combined much longer than the
preceding eight segments combined 13

12. Male genitalia: parameres with basal apodeme forming a pair of subtriangular internal plates (Fig. 15K)
 Thyridomyia (Fig. 15)

Male genitalia: parameres club-shaped, arise from basal apodemes (Fig. 16K) Synthryidomyia (Fig. 16)

13. Third palpal segment broad without distal neck; sensory pit large (Fig. 20B); antenna with first five segments compressed, bearing a pair of hyaline setae (Fig. 20A); parameres absent, aedeagus separated, each with median rounded lobe, anterior arms straight, posterior tip blunt (Fig. 20I) Dacnoforcipomyia (Fig. 20)

Third palpal segment slender or slightly swollen (Fig. 18C); antennal segment 3-10 oval, 11-15 elongated (Fig. 18A); parameres slender joined mesally, arch-like (Fig. 18N), aedeagus subdivided into pair of recurved sclerites, each with apical hook-like process (Fig. 18O). Lasiohelea (Fig. 18)

Genus Dasyhelea Kieffer

Dasyhelea Kieffer, 1911, Bull. Soc. Hist. Nat. Metz, 27:5; 1913,

Rec. Ind. Mus., 9:179, 1913, Ann. Mus. Nat. Hung., 17:48; 1919,

Bull. Soc. Ent. France, :192; Goetghebuer, 1920, Mem. Mus. Roy.

Hist. Nat. Belg., 8:40; Carter, Ingram, and Macfie, 1921, Ann.

Trop. Med. & Parasit., 16:178; Kieffer, 1924, Bull. Soc. R. Ent.

Egypte :253; Edwards, 1926, Trans. Ent. Soc. London, 74:401;

Thienemann, 1926, Mitt. Geogr. Ges. Lubeck, 31:104; Ingram and

Macfie, 1931, Dipt. Pat. & S. Chile, pt. 2, fasc. 4, :177;

Sebess V. Zilahi, 1931, Arch. Hydrobiol. 23:310; Goetghebuer,

1935, Rev. Zool. Bot. Afr., 27:164; Tokunaga, 1940, Tenthredo,

3:116; Zilahi-Sebess, 1940, Folia Ent. Hungar., 5:44; Johannsen,

1948, Ann. Ent. Soc. Amer., 36:778; Tokunaga & Murachi, 1959,

Inst. Micron. 12(3):238; Remm, 1962, Tartu Riik. Ulk. Toim,

120:108; Tokunaga, 1962, Pacif. Ins. 4:189. (Type-species:

Dasyhelea halophila Kieffer. (orig. desig.)

Prokempia Kieffer, 1913, Rec. Ind. Mus., 9:163, 179 (Type-species:

not desig., two orig. incl. spp., Dasyhelea (Prokempia) ornati-

cornis Kieffer and D. (Prokempia) longicornis Kieffer).

Pseudoculicoides Malloch, 1915, Bull. Ill. State Lab. Nat. Hist.,

10:309 (Type-species: Ceratopogon mutabilis Coquillett, orig.

desig.).

Tetrahelea Kieffer, 1925, Arch. Inst. Pasteur d'Algerie, 3:422

(Type-species: Culicoides insignicornis Kieffer, orig. desig.).

Cryptoscena Enderlein, 1936, Tierwelt Mitteleur., 6:51 (Type-species:

Ceratopogon palustris Meigen, mon.).

Dioryctes Enderlein, 1936, Tierwelt Mitteleur., 6:51 (Type-

species: Dasyhelea inclusa Kieffer, mon.)

Tetraneura of authors (not Philippi, 1865).

DIAGNOSIS. Body stout and hairy but not as dense as in Forcinomyia.

Eyes contiguous with short pubescence. Female antennal segments similar in shape, usually with verticils; male antennae with distal four segments elongate. Maxillary palp slender, first segment indistinctly separated, only four segments visible. Humeral pits absent, mesonotum covered with hairs. Legs slender; tarsal segments simple; claws small and equal; empodium small. Wings with macrotrichia over all or part of surface; costa ending about half of wing length; first radial cell obliterated, second radial cell small with square end; median fork sessile or short petiolate. Abdomen stout; one to three spermathecae. Male genitalia with long and tapering ninth tergite, apicolateral processes well developed; basistyles short and broad; dististyles slender to stout, with or without basal branch; aedeagus large, often with paired apodemes; parameres usually asymmetrical, with single median sclerite and pairs of anterior arms.

Approximately 315 species have been described.

Distribution: World-wide.

Very few studies have been made on the biology and early stages of Dasyhelea. Carter, Ingram and Macfie (1921) and Goetghebuer (1925) reported on the early stages of D. bilineata. A key to larvae and pupae was presented by Thienemann (1926) and the life history of Hungarian species, D. geleitana has been worked out by Zilahi-Sebess (1931). Vattier (1965) described the morphology and biology of D. adami from Congo.

The following descriptions are taken from Thomsen (1937), Wirth and Stone (1956) and Wirth (1965):

EGG. Dasyhelea eggs are horseshoe-shaped, the masses are small, detected by microscope.

LARVA. Head oval. Mouthparts hypognathous. Eyes crescent-shaped with heavily pigmented. Mandibles usually three-toothed. Hypopharynx heavily sclerotized, composed of dorsal and ventral parts, with posterior portions bearing teeth. Body segments short and thick, colored by pigmented fat-bodies beneath the hypodermis. Protrusible proleg on last segment bearing hooks. Retractable filamentous anal gills posterior to prolegs.

PUPA. Anal segment with pair of setigerous protuberances in addition to apicolateral processes. Opercula, lacking long setae, with or without hooks in some species.

Adult habits and larval habitats: adults visit flowers, feeding on nectar. The immature stages are semiaquatic. Larvae are found in the blanket algae of ponds or slow streams, algae on dripping banks, and the fermenting sap of tree ulcers. The larvae cannot swim but travel by crawling over the substrate. Most members of the genus spin tubular cases in the last instar.

This genus was erected by Kieffer in 1911 for the Indian species, Dasyhelea halophila. It has characteristics intermediate between Forcipomyia and Culicoides. The wing venation resembles Forcipomyia but tarsi lacks empodium as in Culicoides, however, it can be distinguished from the above genera by the following points: eyes pubescent; palpi four-segmented; wing vein R_1 and R_5 fused forming

a single vein; humeral pits absent; male genitalia: parameres often asymmetrical with paired basal arms and single median lobe.

Dasyhelea is rather a difficult genus. The males are comparatively easier to identify than females. Tokunaga and Murachi (1959) suggested the use of the female subgenital plate for identification.

Subgenus Dasyhelea, s. str.

Wing with one radial cell usually slightly longer than broad, rarely square or missing. Scutum pruinose grayish or bluish. Female antenna with flagella segments basally striped, segment 15 with long apical style. Spermatheca one. Legs usually banded. Male genitalia: ninth sternite not modified, tergite with long apicolateral processes; hook or lobes on inner side of basistyles.

Illustration: Fig. 25 Dasyhelea (Dasyhelea) grisea (Coq.)

Subgenus Dicryptoscena End., 1936

Wing with two radial cells, both longer than broad, more or less equal in length. Palpal segments slender. Female antenna with flagella segments not basally striped, segment 15 with apical style. Spermatheca one, subspherical, with short duct. Male genitalia: ninth tergite with apicolateral processes very short.

Subgenus Pseudoculicoides Malloch, 1915

Subgenus type: Ceratopogon mutabilis Coq.

Wing with second radial cell square or slightly longer than broad. Female antenna with flagella segments not striped, without apical style. Scutum usually dull, black; with or without pruinose gray pattern and rarely shining. Spermatheca one. Male genitalia:

ninth sternite produced caudad in the middle, joined with aedeagus; parameres symmetrical or asymmetrical.

Illustration: Fig. 26 Dasyhelea (Pseudoculicoides) mutabilis Coq.

Subgenus Prokempia Kieffer, 1913

Wing with square second radial cell, macrotrichia scanty.

Female antenna with flagella segments not striped, no apical style.

Scutum usually shining, without pruinose pattern. Spermatheca one.

Male genitalia: aedeagus irregular, H-shaped, separated from caudal border of ninth sternite; latter with two long processes; parameres asymmetrical.

Illustration: Fig. 27 Dasyhelea (Prokempia) cincta (Coq.)

Key for the Subgenera of Dasyhelea

1. Two radial cells present on wing. Dicryptoscena
 One radial cell on wing 2

2. Female antenna with flagella segments basally striped,
 last segment with long apical style (Fig. 25A).
 Second radial cell rarely square (Fig. 25C,D)
 Dasyhelea (Fig. 25)
 Female antenna with flagella segments not striped,
 without apical style (Fig. 26A, 27A). Second
 radial cell square (Fig. 26E, 27D) 3

3. Scutum usually dull, black, with or without pruinose
 gray pattern Pseudoculicoides (Fig. 26)
 Scutum usually shining, without pruinose pattern
 Prokempia (Fig. 27)

Genus Paradasyhelea Macfie

Paradasyhelea Macfie, 1940, Ann. Trop. Med. Parasit, 34:17; Wirth and Lee, 1959, Bull. Brooklyn Ent. Soc., 54:114; Wirth and Blanton (in press). (Type-species: Dasyhelea brevivalpis Ingram and Macfie orig. desig.).

DIAGNOSIS. Eyes widely separated, covered densely with fine hairs. Clypeus hairy. Proboscis short about half as long as the length of the head, vestigial mouth parts. Palpi four-segmented, the largest segment bearing long modified sensory hairs on distal portion, the shallow, small sensory pit indistinct. Antenna 15-segmented. First segment with a row of hairs, third to fifteenth segment uniform in shape. Male antenna plumose. Humeral pits present. Legs slender, tibial comb with four spines, claws small, equal, with bifid tip in male; vestigial hair-like empodium. Wing with short costa, radial cells obliterated, r-m cross vein oblique almost in line with a single radial vein, intercalary fork well developed; anal angle obtuse; macrotrichia abundant. One spermatheca. Male genitalia with ninth sternum excavated posteriorly; ninth tergum with well developed apicolateral processes; basistyles and dististyles simple; aedeagus arched, median part small; parameres appear only as a sclerotized rod connecting the two ventral roots, middle portion broken.

Approximately three species have been described.

Distribution: South America and Australia.

PUPA. Elongate conical as in Culicoides and Dasyhelea, respiratory trumpet stalked, flattened, mid portion wrinkled transversely and bearing papillae around apex. Tubercles of cephalothorax with spines,

abdominal tubercles each with fine hair; apicolateral processes ending in a blade-like spine pointed almost perpendicular to the body.

Macfie (1940a) proposed this genus for Dasyhelea brevipalpis Ingram and Macfie, which he differentiated from Dasyhelea and Forcipomyia, as discussed by Ingram and Macfie (1931). The important characteristic is the unsculptured antennal segments; not binodose in segments 12-14 of male.

Paradasyhelea is closely related to Forcipomyia, Dasyhelea, and Culicoides. It resembles Forcipomyia in having abundant macrotrichea on wing; scutellum hairy; eyes well separated; antennae with sensory pegs scattered. It is similar to Dasyhelea by the following points: palpi four-segmented; eyes hairy; proboscis and mouthparts poorly developed; and the shape of apicolateral processes of ninth tergite in male. Like Culicoides, it has prominent humeral pits; antennal sensory pits and aedeagus Y-shaped.

Illustration: Fig. 28 Paradasyhelea minuta Wirth and Lee

Genus Culicoides Latreille

Culicoides Latreille, 1808, Gen. Crust. et Ins., 4:251; Johannsen, 1905, Bull. N. Y. State Mus., 86:101; Kieffer, 1906, Gen. Insectorum, fasc. 42:53; Johannsen, 1908, Bull. N. Y. State Mus., 124:267; Kieffer, 1913, Rec. Ind. Mus., 9:162; 1919, Ann. Mus. Nat. Hung., 17:31; Goetghebuer, 1920, Mem. Mus. Roy. Hist. Nat. Belg., 8:48; Carter, Ingram and Macfie, 1920, Ann. Trop. Med. Parasit., 14:212; Hoffman, 1925, Amer. Hyg., 5:274; Edwards, 1926, Trans. Ent. Soc. London, 74:403; Johannsen, 1931, Arch. f. Hydrobiol., Suppl., 9:428; Mukerji, 1931, Ind. J. Med. Res.,

18:1054, 1056; 1931, Nature, 127:339; Pomerantzen, 1932, Mag. Parasit. Leningrad, 3:183; Vimmer, 1932, Sborn. Ent. Odd. Narod. Mus. Prazě 10:132; Goetghebuer, 1933, Flieg. Pal. Reg. 13a:37; 1935, Rev. Zool. Bot. Afr., 27:170; Tokunaga, 1937, Tenthredo, 1:273; Costa Lima, 1937, Mem. Inst. Oswaldo Cruz, 32:411; Root and Hoffman, 1937, Amer. J. Hyg., 25:156; Macfie, 1937, Proc. Roy. Ent. Soc. London (B), 6:112; Causey, 1938, Amer. J. Hyg., 27:399; Kono and Takahasi, 1940, Ins. Mats. 14:69; Tokunaga, 1940, Tenthredo, 3:141; Takahasi, 1941, Ins. Matsum. 15:80; Zilahi-Sebess, 1941, Folia Ent. Hung., 6:32; Fox, 1942, Puerto Rico J. Pub. Health and Trop. Med., 17:412; James, 1943, Pan-Pacif. Ent., 19:148; Johannsen, 1943, Ann. Ent. Soc. Amer., 36:779; Colaco, 1946, Ann. Inst. Med. Trop. Lisbon, 3:222; Fox, 1946, Ann. Ent. Soc. Amer., 39:248; Barbosa, 1947, Ann. Soc. Biol. Pernambuco, 7:3; Hill, 1947, Ann. Trop. Med. Parasit., 41:55; Macfie, 1948, Ann. Trop. Med. Parasit., 42:67; Fiedler, 1951, Onderstepoort J. Vet. Res., 25:10; Wirth, 1951, Ann. Ent. Soc. Amer. 44:76; Downes and Kettle, 1952, Proc. R. Ent. Soc. Lond. (B), 21:77; Goetghebuer, 1952, Biol. Jaarb., 19:186; Gutsevich, 1952, Parazit. Sborn. Zool. Inst. Akad. Nauk SSSR, 14:79; Kettle and Lawson, 1952, Bull. Ent. Res., 43:428; Lee and Reye, 1953, Proc. Linn. Soc. N.S.W., 77:373; Ortiz, 1953, Rev. Sanid. Asist. Soc. 18:9; Foote and Pratt, 1954, Publ. Hlth. Monogr., Washington No. 18:10; Fox, 1955, J. Agr. Univ. P. R., 39:219; Kettle and Lawson, 1955, Proc. R. Ent. Soc. Lond. (B) 24:46; Ortiz and Leon, 1955,

Bol. Inf., Cient. Nac. 7, No. 67:566; Arnaud, 1956, Microentomology, 21:134; Jones, 1956, Proc. Ent. Soc. Wash., 58:25; Lewis, 1956, Canad. Ent., 88:551; Forattini, 1957, Agr. Fac. Hig. Univ. S. Paulo, 11:194; Khalaf, 1957, Amer. Midl. Nat. 58:187; Wirth and Blanton, 1956, Proc. Ent. Soc. Wash., 58:308; Wirth, 1958, J. Kansas Ent. Soc., 31:85; De Prada and Gil Collado, 1959, Med. Trop. Madrid, 34:423; Ortiz, 1959, Rev. Sanid., Asist. Soc., 24:355; Sen and Das Gupta, 1959, Ann. Ent. Soc. Amer., 52:629; Tokunaga, 1959, Pacif. Ins., 1:204; Tokunaga and Murachi, 1959, Ins. Micron., 12, No. 3:322; Wirth and Blanton, 1959, Proc. U. S. Nat. Mus., 109:262; Wirth and Hubert, 1959, Pacif. Ins., 1:5; Campbell and Pelham-Clinton, 1960, Proc. Roy. Soc. Edinb. (B) 67:196; Gutsevich, 1960, Opred. Faune SSSR, 72:44; Wirth and Hubert, 1960, Ann. Ent. Soc. Amer., 53:648; Callot and Kremer, 1961, Ann. Parasit. Hum. Comp. 36:686; Delfinado, 1961, Fieldiana (Zool.), 33:636; Hubert and Wirth, 1961, Proc. Ent. Soc. Wash., 63:236; Jones, 1961, Ann. Ent. Soc. Amer., 54:741; Khalaf, 1961, Beitr. Ent. 11:450; Nagaty and Morsey, 1961, J. Arab. Vet. Med. Ass., 21:364; Pais Cairo, 1961, Estud. Ens. Docum. Jta. Inv. Ultramar., No. 86:46; Wirth and Hubert, 1961, Pacif. Ins. 3:12; Galukhova, 1962, Trudy. Zool. Inst. Akad. Nauk SSSR, 31:218; Tokunaga, 1962, Pacif. Ins. 4:203, 458; Wirth and Hubert, 1962, Ann. Ent. Soc. Amer., 55:184; Jambback and Wirth, 1963, Ann. Ent. Soc. Amer., 56:186; Tokunaga, 1963, Plant Prot. Bull. 5:120; Wirth and Blanton, 1967, Fla. Ent. 50(3):209. (Type-species: Culex pulicaris Linnaeus, as Culicoides punctata Latreille, orig. desig.)

Oecacta Poey, 1851, Mem. Hist. Nat. Isla Cuba, 1:236 (Type-species:

Oecacta furens Poey, mon.).

Psychophaena Philippi, 1865, Verh. Zool.-Bot. Ges. Wien, 15:628

(Type-species: Psychophaena pictipennis Philippi, mon.).

Haematomyidium Goeldi, 1905, Mem. Mus. Goeldi, 4:137 (Type-species:

Haematomyidium paraense Goeldi, orig. desig.).

Cotocripus Brethes, 1912, Ann. Mus. Nac. Buenos Aires, 22:451

(Type-species: Cotocripus caridei Brethes, mon.).

Haemophoructus Macfie, 1925, Bull. Ent. Res., 15:349 (Type-species:

Haemophoructus maculipennis Macfie, mon.).

Synhelea Kieffer, 1925, Arch. Inst. Pasteur d'Algerie, 3:423

(Type-species: ?).

Prosapelma Kieffer, 1925, Arch. Inst. Pasteur d'Algerie, 3:417

(Type-species: Prosapelma cinerea Kieffer, orig. desig.).

Hoffmania Fox, 1948, Proc. Biol. Soc. Wash., 61:21 (Type-species:

Culicoides inamollae Fox and Hoffman, orig. desig.).

DIAGNOSIS. Body slender, with moderate hairs. Eyes usually bare. Female antennae with segments 3-10 oval or rounded and usually much shorter than the last five segments which are usually cylindrical in shape. Male antennae plumose, three apical segments long. Mesonotum usually with pattern, covered with short hairs and usually with few bristles; humeral pits well developed. Legs and tarsi simple; claws of both sexes tiny but equal; empodium vestigial. Wings densely covered with microtrichia; macrotrichia always present near wing tip; wings often with spotted pattern; costa usually to two-thirds wing

length; two radial cells, almost equal; media petiolate with parallel branches. Male genitalia with ninth sternite short, with mesal excavation; ninth tergite usually with apicolateral processes present; basistyle often with both dorsal and ventral root developed; dististyle long and curved; aedeagus variable, usually cone-shaped with anterior lateral arms; parameres usually separate with sharp point or irregular shape.

Approximately 1000 species have been described.

Distribution: World-wide.

The immature stages of Culicoides have been studied by several authors. The American species were described by the following authors: Painter (1926), Dove, Hall and Hull (1932), Thomsen (1937), Fox (1942), Smith and Lowe (1948), Williams (1951), Wirth (1952), Jamnback, Wall and Collins (1958), Jones (1961). On the European species, the studies had been done by: Rieth (1922), Thienemann (1928), Lenz (1934), Mayer (1934) and Jobling (1953); descriptions of the British species have been given by: Hill (1947), Downes (1950), Lawson (1951) and Kettle and Lawson (1952).

Culicoides immature stages were reported; from Africa by Goetghebuer (1933), Carter, Ingram and Macfie (1920), and Ingram and Macfie (1921); from Brazil by Lutz (1912), Forattini, Rabello and Pattoli (1956, 1960); from India by Patton (1913) and Patel (1921); from French Guiana by Forattini and Rabello (1956); and from Japan by Tokunaga (1937).

Particularly detailed descriptions have been given by Carter, Ingram and Macfie (1920), Hill (1947), Kettle and Lawson (1952) and Jones (1961).

Breeding places of Culicoides were reported by Lutz (1912), Rieth (1922), Thorpe (1927), Jobling (1929), Mayer (1934), Buckley (1938), Wirth, O. M., W. W. Wirth and F. S. Blanton (1968).

EGGS. Eggs are elongated and slightly curved. They are deposited in masses.

LARVA. Larvae are eel-like form, without prolegs. The body segments are short and thick cylinders, each segment carrying a pair of lateral setae. The last segment bears three pairs of anal setae, short and light in color. The head is well sclerotized with prognathous mouthparts. Mandibles are curved. Pharyngeal skeleton has combs.

PUPA. The pupa is well sclerotized. It has dark brown color and is free from larval exuvium. Respiratory organ is elongated, tubular, and constricted at the base. The operculum is either with or without spines. The anal segment has one pair of apicolateral spines.

Adult habits and larval habitats: The adults are generally most active at dawn and dusk (Kettle, 1962). Their flight and other activities are strongly influenced by temperature and wind and other conditions. The females require a blood meal, but males feed only on nectar or plant juices. Each species has a range of vertebrate hosts on which it will feed. Feeding may occur anytime, but some species are crepuscular. The resting places are usually in damp cool situations, such as algae, the base of trees, moss, grass or dead leaves (Kettle, 1962).

Larvae may be found in a wide variety of moist environments, such as ponds, creeks, lakes, tree holes, slime-covered bark, rotting forest litter, rotting banana stalks. In the recent paper, Wirth, O. M., W. W. Wirth and F. S. Blanton (1968) reported finding two

habitats of Panama Culicoides. These habitats were rotting spadices of the Panama hat palm, Carludovica palmata Ruiz and Pavon and older decay-ing in florescences of the "beefsteak heliconia" Heliconia mariae Hooker.f.

The majority of the species of this genus may be recognized by having spotted wings which is absent in some species. Malloch (1915) was the first to show the sensory pits as a distinct generic character. These pits do not appear in Dasyhelea, the nearest genus to Culicoides. They are present in Ceratopogon, Monohalea and some Stilobezzia, which can be differentiated from Culicoides since the females have large claws or modified legs.

This genus comprises a large number of species widely distributed over the world. Many attempts have been made to divide Culicoides into subgenera. The important references are Vargas (1960) who separated the subgenera based on wing patterns and male genitalia and Fox (1955) who emphasized only the male genitalia.

Subgenus Culicoides s. str.

Cell R_5 with a marginal dark spot shaped like an hour-glass; cubital fork in dark area; second radial cell in light spot. Male genitalia: basistyles short and strong pilosity at the inner margin; parameres with short hairs at tip; aedeagus V-shaped.

Illustration: Fig. 29 Culicoides (Culicoides) yukonensis Hoffman

Subgenus Trithecoides Wirth and Hubert, 1959

Subgenus type: Culicoides flaviscutatus W. & H., 1959 (orig. desig.)

Characters as follow: three well developed spermathecae; second

radial cell long; wing with two pale areas, over r-m and over apex of second radial cell; large pale area on the basal part of wing across extreme wing tip. Male genitalia with ventral root reduced; aedeagus blunt tip.

Illustration: Fig. 30 Culicoides (Trithecoides) flaviscutatus W. & H.

Subgenus Haemophoructus Macfie, 1925

Subgenus type: Haemophoructus maculipennis Macfie (orig. desig.)

Female wing with a single radial cell.

Illustration: Fig. 31 Culicoides (Haemophoructus) gemellus Macfie

Subgenus Meijerehelea Wirth and Hubert, 1961

Subgenus type: Ceratopogon guttifer Meijere (orig. desig.)

One spermatheca; wing with costal pale spot in cell R₅ immediately distal to second radial cell and a round pale spot at extreme apex of cell. Male genitalia: aedeagus usually flaring at tip; parameres with large basal knob directed laterad.

Illustration: Fig. 32 Culicoides (Meijerehelea) guttifer (Meijere)

Subgenus Hoffmania Fox, 1947

Subgenus type: Culicoides inanollae Fox and Hoffman (orig. desig.)=
insignis Lutz, 1913.

Pale spot on vein M₂; cubital fork in light area; macrotrichia abundant; r-m crossvein dark with large light spot. Male genitalia: aedeagus bottle-shaped, parameres fused in some species.

Illustration: Fig. 33 Culicoides (Hoffmania) insignis Lutz

Subgenus Avaritia Fox, 1955

Subgenus type: Ceratopogon obsoletus Meigen (orig. desig.)

Wing marking faint; macrotrichia scanty. Male genitalia: ninth tergite without apicolateral processes; ventral root of basistyle very long.

Illustration: Fig. 34 Culicoides (Avaritia) obsoletus (Meig.)

Subgenus Oecacta Poey, 1851

Subgenus type: Oecacta furens Poey (mon.)

Second radial cell in dark spot; clear spot on vein M_2 absent; three pale spots on M_1 . Male genitalia: ventral root with retrorse tooth; parameres with spinose tip; aedeagus triangular.

Illustration: Fig. 35 Culicoides (Oecacta) furens (Poey)

Subgenus Drymodesmyia Vargas, 1960

Subgenus type: Culicoides copiosus Root and Hoffman, 1937 (orig. desig.)

Wing hairy; second radial cell within dark area; cell R_5 with two pale spots, one is about the middle of cell. Male genitalia: basistyles with ventral hook, dististyles hook-shaped, paramere with sharp tip.

Illustration: Fig. 36 Culicoides (Drymodesmyia) copiosus R. & H.

Subgenus Diphaeomyia Vargas, 1960

Subgenus type: Culicoides baueri Hoffman, 1925 (orig. desig.)

Male genitalia with ventral root long, curved, rounded apically with a small notch at base; parameres with many short spines.

Illustration: Fig. 37 Culicoides (Diphaeomyia) baueri Hoffman

Subgenus Anilomyia Vargas, 1960Subgenus type: Culicoides covagarciai Ortiz, 1950

Wing with darkest spot occurring basal to second radial cell.

Male genitalia with inner margin of basistyle spinose; aedeagus bottle-shaped; parameres fused or closely appressed with a terminal brush.

Illustration: Fig. 38 Culicoides (Anilomyia) covagarciai OrtizSubgenus Beltranmyia Vargas, 1953Subgenus type: Culicoides crepuscularis Malloch, 1915 (orig. desig.)

Wing dark with pale markings and many long hairs. Male genitalia: aedeagus V- or Y-shaped, truncate, broad tip.

Illustration: Fig. 39 Culicoides (Beltranmyia) crepuscularis MallochSubgenus Glaphiromyia Vargas, 1960Subgenus type: Culicoides scopus Root and Hoffman, 1937 (orig. desig.)Wing with pale spot on vein M_1 and M_2 ; r-m crossvein dark in some species. Male genitalia: ventral root long and sharp; parameres with terminal hairs; aedeagus arch-shaped.Illustration: Fig. 40 Culicoides (Glaphiromyia) scopus R. & H.Subgenus Haematomyidium Goeldi, 1905Subgenus type: Culicoides paraensis (Goeldi, 1905)

Crossvein r-m usually dark but clear basally. Male genitalia: ventral root well developed with retrorse tooth; parameres with spinose tips; aedeagus rounded apically.

Illustration: Fig. 41 Culicoides (Haematomyidium) paraensis (Goeldi)

Subgenus Macfiella Fox, 1955Subgenus type: Ceratopogon phlebotomus Williston

Second radial cell in a dark spot. Male genitalia with ninth tergite rounded apically; basal root long; dorsal root somewhat boot-shaped.

Illustration: Fig. 42 Culicoides (Macfiella) phlebotomus (Will.)Subgenus Mataemyia Vargas, 1960

Subgenus type: Culicoides mojingaensis Wirth and Elanton, 1953
(orig. desig.)

Vein M_1 usually without pale spot; M_1 and M_2 with long light bands. Ventral root of male genitalia prominent; parameres sharp pointed.

Illustration: Fig. 43 Culicoides (Mataemyia) mojingaensis W. & B.Subgenus Monoculicoides Khalaf, 1954Subgenus type: Ceratopogon nubeculosus Meigen (orig. desig.)

Wing with second radial cell in a dark spot. One spermatheca. Male genitalia with paramere fused forming a plate and usually bifid distally; aedeagus deeply bifid; dorsal root often boot-shaped.

Illustration: Fig. 44 Culicoides (Monoculicoides) variipennis (Coq.)Subgenus Selfia Khalaf, 1954Subgenus type: Culicoides hieroglyphicus Malloch (Orig. desig.)

Wing dark without pale marking. Spermathecae not apparent. Male genitalia with parameres fused. Aedeagus with two sclerotized pieces often fused apically.

Illustration: Fig. 45 Culicoides (Selfia) hieroglyphicus Malloch

Key for the Subgenera of Culicoides

1. Spermathecae unsclerotized, not apparent; wing dark
 - without pale marking Selfia (Fig. 45)
- Spermathecae sclerotized; wing usually with distinct
 - pale spots 2
2. One spermatheca 3
 - Two to three spermathecae 5
3. Parameres separated 4
 - Parameres fused to form a plate usually bifid distally
 - with two apical points (Fig. 44.0) . . Monoculicoides (Fig. 44)
4. Paramere with large basal knob directed laterad (Fig. 32P),
 - stem short, rather stout simple tip without distal
 - fringing spines. Meijerehelea (Fig. 32)
 - Paramere with small base, tapering, directed basally,
 - and pointed tip. (Fig. 39.0) Beltranmyia (Fig. 39)
5. Three well developed spermathecae (Fig. 30M). Trithecoides (Fig. 30)
 - Two well developed spermathecae 6
6. Female wing with a single radial cell (Fig. 31E)
 - Haemophoructus (Fig. 31)
 - Female wing with two radial cells, almost equal in size . . . 7
7. Ventral root absent or poorly developed 8
 - Ventral root large and well developed 10

8. Base of paramere sharply bent and close together, tip
 with short hairs (Fig. 29L); wing without pale
 spot on vein M_2 Culicoides (Fig. 29)
 Base of paramere gradually bent; wing with pale spot
 on vein M_2 9
9. Wing with cubital fork in a dark area (Fig. 38E)
 Anilomyia (Fig. 38)
 Wing with cubital fork in a light area (Fig. 33E)
 Hoffmania (Fig. 33)
10. Second radial cell included in a pale area (Fig. 34E)
 Avaritia (Fig. 34)
 Second radial cell included in a dark area 11
11. Middle of vein M_2 not straddled by pale spot 12
 Middle of vein M_2 straddled by pale spot 13
12. Vein M_1 and M_2 within long dark bands (Fig. 41E); ventral
 root with retrorse tooth (Fig. 41N). Haematomyidium (Fig. 41)
 Vein M_1 and M_2 within long pale bands (Fig. 43D);
 ventral root prominent Mataemyia (Fig. 43)
13. Vein M_1 and M_2 within dark bands 14
 Vein M_1 and M_2 within pale bands 15
14. Third palpal segment with sensory pit scattering, without
 a true pit (Fig. 42C); aedeagus without a prominent arch,
 apical portion long, truncate distally, basally with a
 long, curved hook-like pointed processes (Fig. 42N)
 Macfiella (Fig. 42)

Third palpal segment with a true and large sensory pit

(Fig. 40C); aedeagus arch with long stem (Fig. 40N)

..... Glaphiromyia (Fig. 40)

15. Aedeagus with small, tapering tip, with short process on arch

(Fig. 37N) Diphaeomyia (Fig. 37)

Aedeagus with broad or truncate tip, without process

on arch 16

16. Base of paramere bent perpendicularly, sharp tip, not

spinose (Fig. 36·0) Drymodesmyia (Fig. 36)

Base of paramere small and gradually bent, subapical

portion with globose process and tip spinose (Fig. 35·0)

..... Oecacta (Fig. 35)

Genus Austroconops Wirth and Lee

Austroconops Wirth and Lee, 1958, Proc. Linn. Soc. N. S. Wales,

83:337 (Type-species: Austroconops mcmillani Wirth and Lee,
mon.)

DIAGNOSIS. Eyes hairy, contiguous above; vertex sparsely haired. Antenna 15-segmented, flagella segments spherical basal, becoming oval distally. Clypeus small, with four long hairs; proboscis shorter than head; mouthparts well developed, mandible with eight large teeth. Palpi "four-segmented," the fourth and fifth segments fused; third segment swollen without sensory pit, sensoria covered almost half of the mid portion of the segment. Thorax robust, humeral pits conspicuous. Legs unarmed; hind tibia with plumose spur, tibial comb four spines. Claws small and equal; empodium rudimentary. Wing milky, radial veins distinctly thickened, costa long, r-m crossvein very oblique, forming almost a straight line with base of media and posterior side of radial cells; radial cells long and broad; media with long petiole; anal cell large; macrotrichia absent. Abdomen short with blunt apex and short cerci. Two subequal spermathecae and a rudimentary one. Male unknown.

Only one species known.

Distribution: W. Australia.

Adult habits and larval habitats: Female blood sucking, immature stages unknown.

This genus was erected in 1958 by Wirth and Lee for Austroconops mcmillani of Australia. It has not been discovered outside the Australian region.

The members of this genus have the characteristics of Culicoides, Leptoconops and Stilobezzia. It resembles Leptoconops by the following characters: palpi four-segmented, fourth and fifth segments fused into one segment. Wing milky white, without macrotrichea; empodium absent; antennal segments similar in size and shape; blood sucking habit diurnal. Wing venation is similar to Stilobezzia, with long costa and well developed radial cells and petiolate-media. It has the characteristics of Culicoides in having the humeral pits on pronotum; small and equal claws, empodium vestigial; antennal segments not sculptured.

Illustration: Fig. 46 Austroconops mcmillani Wirth and Lee

Genus Camptopterohelea Wirth and Hubert

Camptopterohelea Wirth and Hubert, 1960, Fieldiana (Zool.), 42(7):89

(Type-species: Camptopterohelea hoogstraali Wirth and Hubert, (mon.)

DIAGNOSIS. Eyes bare, widely separated. Antenna 15-segmented, cylindrical. Palpi very short, only two segments present; the third and the fused segment of the fourth and the fifth. Proboscis vestigial, shorter than palpus, mandibles with very fine teeth. Thorax dark and stout; scutum with anterior median pair of oval hyaline pits and few hairs. Legs rather stout; front tibia with a lanceolate spur and a compact comb, hind tibia with more hairs on comb; each tarsomere bearing a single long, stout, slightly curved claw. Wing broad on basal half and tapering distally; costa long; two radial cells present, the first one well developed but the second one small, the radial veins thickened; the rest of the wing venation includes the cubital stem, 1A and possibly Cu₁ appears from posterior wing fold to margin of the wing.

Disc of wing modified with two folds transversely continuous from costal end to end of Cu_1 proximally and about halfway from this line to wing tip distally, fold areas densely covered with microtrichia; along vein Cu_1 with long, spinelike microtrichia as well as over radial cells and along margin of proximal fold and the patch in front of the distal fold; macrotrichia absent. Abdomen stout with single oval spermatheca. Male genitalia small; ninth tergite rounded; basistyle rather stout, dorsal root prominent; dististyle slender, tapering with hook-like tip; aedeagus arched with large body.

Only one species known.

Distribution: Philippines, Malaya.

This genus is readily separated from the other genera by having two-segmented palps; proboscis rudimentary; all claws single; wing greatly modified with broad basal half and tapering distally; wing venation with only radial vein, cubital stem and the first anal vein present; microtrichia spinelike.

Illustration: Fig. 47 Camptopterohelena hoogstraali W. & H.

Genus Ceratopogon Meigen

Ceratopogon Meigen, 1803, Illiger's Mag. Ins., 2:261; Kieffer, 1899, Bull. Soc. Ent. France, p. 69; Johannsen, 1903, Bull. N. Y. State Mus., 86:97; Kieffer, 1906, Gen. Insectorum, fasc. 42:48; 1919, Ann. Mus. Nat. Hung., 17:1; Goetghebuer, 1920, Mem. Mus. Roy. Hist. Nat. Belg. 8:19; Edwards, 1920, Ann. Mag. Nat. Hist., 6:129; 1926, Trans. Ent. Soc. London, 74:407; Johannsen, 1934, J. N.Y. Ent. Soc., 42:343; Tokunaga, 1940, Tenthredo, 3:151; Johannsen, 1943,

- Ann. Ent. Soc. Amer., 36:780; Wirth, 1952, Univ. Calif. Publ. Ent., 9:198; de Meillon, 1959, S. Afr. Anim. Life, 6:340; Clastrier, 1961, Inst. Pasteur Alger., 39:401; Tokunaga, 1964, Pacif. Ins. 6:292. (Type-species: Tipula barbicornis Fabricius, mon. ?= Ceratopogon communis Meigen).
- Helea Meigen, 1800, Nouv. Class. des mouches a deux ailes, p. 18; Goetghebuer and Lenz, 1933, in Lindner, Flieg. Pal. Reg., 77:5, 48; Stone, 1941, Ann. Ent. Soc. Amer., 34:411 (Type-species: Ceratopogon communis Meigen, desig. Coquillett, 1910).
- Brachypogon Kieffer, 1899, Bull. Soc. Ent. France, p. 69 (Type-species: Ceratopogon vitiosus Winnertz, orig. desig.).
- Psilohelea Kieffer, 1917, Ann. Mus. Nat. Hung., 15:294 (Type-species: Ceratopogon candidatus Winnertz, mon.; = niveipennis Meigen).
- Isohelea Kieffer, 1917, Ann. Mus. Nat. Hung., 15:295 (Type-species: Ceratopogon lacteipennis Winnertz, desig. Kieffer, 1919; = sociabilis Goetghebuer).
- Anakempia Kieffer, 1924, Bull. Soc. Hist. Nat. Moselle, 30:13 (Type-species: Anakempia grandiforceps Kieffer, orig. desig.).
- Fanthamia de Meillon, 1939, Ruwenzori Exped., 1934-35, 1(5):103 (Type-species: Ceratopogon (Fanthamia) adulator de Meillon, orig. desig.).
- DIAGNOSIS. Body stout with few hairs. Eyes pubescent. Female antennal segments 3-10 rounded, the last five segments oval; male antennae plumose with last three segments longer than the preceding ones. Legs slender; empodium vestigial or absent; claws large in female, equal or almost equal. Wing without microtrichia and

macrotrichia or with few macrotrichia near the wing tip; costa slightly longer than the middle of wing; usually with two radial cells, about the same size; intercalary fork indistinct; median fork usually with lower branch absent or interrupted. Male genitalia not inverted; ninth tergite small; basistyles swollen; aedeagus varies; parameres separate.

Approximately 219 species have been described.

Distribution: World-wide.

Kettle and Lawson (1952) was the only paper published on the immature stages and the breeding places of Ceratopogon of British species.

LARVA. Head with posterior ventral suture long, well sclerotized and pigmented. Antennae more prominent (Isophelea) or indistinct (Ceratopogon). Dorsal comb with seven to nine teeth on each side.

PUPA. Thorax dark, nodular. Operculum dark, covered with dark nodules; respiratory horn short and stout, very dark, except at the tip. Metathorax not indentate. Caudal spine dark.

Breeding places always are associated with Culicoides. They were reported found in moorland, in marshes and often in large numbers in Sphagnum spp.

This genus is closely related to Culicoides but the wing^{is} without microtrichia or pattern and the claws are very large.

Subgenus Ceratopogon s. str.

Vein M_2 complete or narrowly interrupted; both radial cells distinct, longer than broad.

Illustration: Fig. 48 Ceratopogon (Ceratopogon) culicoidithorax
Hoffman.

Subgenus Isohelea Kieffer, 1917

Subgenus type: Ceratopogon lacteipennis Winnertz (orig. desig.)
sociabilis Goet.

Vein widely interrupted at base; costa short not much beyond
 the middle of wing; radial cell small or absent.

Illustration: Fig. 49 Ceratopogon (Isohelea) stigmalis Coq.

Subgenus Brachypogon Kieffer, 1899

Subgenus type: Ceratopogon vitiosus Winnertz (orig. desig.)

Wing with second branch of media absent.

Subgenus Nilohelia Kieffer, 1921

Subgenus type: Nilohelia albipennis Kieffer (mon.)

Wing with first and second radial cell obliterated.

Subgenus Fanthamia de Meillon, 1939

Subgenus type: Ceratopogon adulator de Meillon.

Wing with complete first radial cell, second one obliterated;
 male antenna as in female; hind claws of female greatly unequal;
 macrotrichia present on distal portion of wing.

Key for the Subgenera of Ceratonogon

1. Two complete radial cells present 2
 One or both radial cells obliterated 4
2. Second branch of media present 3
 Second branch of media absent Brachynogon
3. M_2 complete or narrowly interrupted at base, costa
 ending about two-thirds of wing length (Fig. 48E)
 Ceratonogon (Fig. 48)
 M_2 widely interrupted at base, costa ending about the
 middle of wing (Fig. 49C). Isochelea (Fig. 49)
4. First and second radial cells obliterated Milchelea
 First radial cell complete, second obliterated Fantharia

Genus Alluaudomyia Kieffer

Alluaudomyia Kief., 1913, Voyage Ch. Alluaud et R. Jeannel en Afrique Orientale, Dipt. 1:12; de Meillon, 1939, J. Ent. Soc. S. Africa 2:7; Okada, 1942, Trans. Nat. Hist. Soc. Formosa 32:315; Wirth, 1952, Ann. Ent. Soc. Amer. 45:423; Tokunaga and Murachi, 1959, Ins. Micron. 12(3):352; Clastrier, 1961, Arch. Inst. Pasteur Alger; 39:428; Tokunaga, 1963, Pacif. Ins. 5:215; Wirth and Delfinado, 1964, Pacif. Ins. 6:602. (Type-species: Alluaudomyia imoarunguis Kief. mon.).

Neoceratopogon Malloch, 1915, Bull. Ill. State Lab. Nat. Hist., 11:310 (Type-species: Ceratopogon bellus Coquillett).

Prionognathus Carter, Ingram and Macfie, 1921, Ann. Trop. Med. & Parasit., 16:309 (Type-species: Prionognathus marmoratus Carter, Ingram and Macfie, orig. desig.).

Thysanognathus Ingram and Macfie, 1922, Ann. Trop. Med. & Parasit., 16:244 (n. nom. for Prionognathus Carter, Ingram and Macfie, not Laferte-Senectere, 1851).

Isoecacta Garrett, 1925, Seventy New Diptera, p. 9. (Type-species: Isoecacta poeyi Garrett, mon.).

DIAGNOSIS. Body slender, moderately hairy, mostly small size. Eyes bare or hairy, separated or contiguous. Female antennal segments 3-10 long, segments 11-15 elongated. Male antennae with well developed plumes. Palpi slender; third segment simple. Wing without microtrichia, macrotrichia appearing along the wing tip, wing usually with 1-15 or 20 small dark spots and sometimes with grayish streaks along the wing veins; male wing bare or hairy. One radial cell present (the first one

completely fused), media petiolate. Legs slender, in some species with long hairs. Male claws small and equal; female claws very unequal in hind legs, inner claw longer. Spermathecae one or two. Male genitalia highly modified; ninth tergite always long, usually with well developed apicolateral processes; ninth sternite short, concave mesally; basistyle and dististyle simple; aedeagus arched with large stem; parameres usually separated.

Approximately 122 species have been described.

Distribution: North America, Europe, Africa, Asia, and Pacific Islands.

Immature stages and biology of Alluaudomyia of North American species have been reported in Thomsen (1937), Williams (1953) and Wirth and Stone (1956).

EGG. Long and narrow, almost straight. Eggs of A. needhami placed side by side horizontally, forming a flat ribbon-like band, not jelly covered.

LARVA. Brown with pear-shaped head. The dorsal side of the body colored by pigments in the fat bodies, causing the larva to appear dark red. Last body segment with eight setae as long as or longer than last segment, with addition of four short setae.

PUPA. Light brown with dark thorax. Respiratory trumpet funnel-form, covered entirely with scales; respiratory spiracles arranged in pairs. Cuticular projections on the body segments vary in shape and number. Last segments with slender and pointed projections.

Larval habitats: larvae of Alluaudomyia were found in algae and in mud in New York. Thomsen (1937) reported that larvae of A. splendida were found in algae, decaying leaves from swamps, and in the mud

near the edge of ponds in New York; A. needhami larvae were found in blanket algae in ponds. The larvae are predaceous. Williams (1953) summarized three breeding habitats of A. bella and A. needhami as follows: areas of permanent flowing water to areas of temporary water where the soil is firm enough to walk on; soil with dense growth of vegetation to areas with no vegetation and in sunny areas where the temperature reaches 90°F as well as shady areas; pH of soil may range from 5.7 to 7.3.

This genus has distinctive characters and is readily recognized from the other genera in the following points: wing usually adorned with one to twenty small black spots; microtrichia absent; empodium vestigial and claws of female unequal on hind legs.

Illustrations: Fig. 50 Alluaudomyia bella (Coq.) and Fig. 51 Alluaudomyia parva Wirth.

Genus Stilobezzia Kieffer

Stilobezzia Kieffer, 1911, Rec. Indian Mus., 6:118; 1913, Rec. Indian Mus., 9:184; 1917, Ann. Mus. Nat. Hungarici, 15:307; 1919, Bull. Soc. Ent. France 34:192; Goetghebuer, 1920, Mem. Mus. Roy. Hist. Nat. Belgique, 8:59; Carter, Ingram, and Macfie, 1921, Ann. Trop. Med. Parasit., 15:324; Edwards, 1926, Trans. Ent. Soc. London, 74:411; 1929, Notulae Ent., 9:9; Johannsen, 1931, Arch. Hydrobiol. Suppl., 9:430; Ingram and Macfie, 1931a, Dipt. Patagonia and S. Chile, pt. 2, fasc. 4:191; Macfie, 1932, Ann. Trop. Med. Parasit., 26: 41; de Meillon, 1938, Proc. Roy. Ent. Soc. London (B), 7:266; Tokunaga, 1940b, Tenthredo, 3:154; Johannsen, 1943, Ann. Ent.Soc.

Amer., 36:781; Lane, 1947, Rev. Ent., 18:197; Lee, 1948, Proc Linn. Soc. N. S. W., 72:345; Wirth, 1953, Proc. U. S. Nat. Mus., 103:57; Lane and Forattini, 1958, Rev. Bras. Ent., 8:203; Tokunaga and Murachi, 1959, Ins. Micron. 12(3):363; Tokunaga, 1959, Pacif. Ins. 1:298; Lane and Forattini, 1961, Rev. Bras. Ent., 10:83; Tokunaga, 1962, Pacif. Ins. 4:207; Clastrier, 1963, Arch. Inst. Pasteur Algerie 41:41; Tokunaga, 1963, Pacif. Ins. 5:249; Das Gupta and Wirth, 1968, U. S. Nat. Mus. Bull., 283:16.
(Type-species: Stilobezzia festiva Kieffer, orig. desig.)

Hartomyia Malloch, 1915, Bull. Ill. State Lab. Nat. Hist., 10:339

(Type-species: Ceratopogon pictus Coquillett, orig. desig.).

Neostilobezzia Goetghebuer, 1934, in Lindner, Flieg. Pal. Reg., 78:53

(Type-species: genotype not designated).

DIAGNOSIS. Large size, slender with sparsely hairs. Eyes bare. Antennae of female with segments 3-10 oval to short cylindrical, segments 11-15 strongly cylindrical; male antennae plumose, hairs well developed on segments 3-12. Mesonotum with or without few bristles; humeral pits inconspicuous. Legs slender, without spines in all femora; fourth tarsal segment cordiform, fifth segment elongated and usually clavate; first tarsal segment of mid leg bearing subbasal spur; female claws very large and unequal, bifid; male claws small and equal; empodium absent. Wing long with few macrotrichia along wing tip; costa long; two radial cells present, second one well developed; median fork distinctly petiolate and long. Usually two spermathecae and a third small one. Male genitalia: very short ninth sternite; ninth tergite rounded; basistyle and dististyle simple; aedeagus

reduced to pair of oblique lateral sclerites; parameres with modified, well developed submedian processes.

Approximately 248 species have been described.

Distribution: World-wide.

The immature stages and biology are not well known. Few species have been described. The pupa of spirogyrae was described by Carter, Ingram and Macfie (1921). Ingram and Macfie (1922) gave the description of immature stages of poikiloptera from West Africa. In Europe, Thienemann (1928) gave the figures of the pupa of gracilis. Kettle and Lawson (1952) included two instars of ochracea and gracilis in their paper. Mayer (1934) studied the Dutch East Indies species of perspicua, and the pupa of soror. Thomsen (1937) described and illustrated antennalis and bulla early stages from New York. Lane, Forattini, and Rabello (1955) described and illustrated pupa of glauca and wygodzinsky from Brazil.

LARVA. Mouthparts reduced, directed anteriorly. Head capsule well developed; pharyngeal skeleton with several combs, principal comb of pharyngeal angulus undivided; larva without prolegs but with caudal bristles. Last abdominal segment without terminal hooks, with only short setae (Thomsen, 1937).

PUPA. As in Culicoides but differs in having trumpet constricted basally; no spines on operculum.

Adult habits and larval habitats: adult habits are poorly known. Edwards (1920b) indicated that the female of S. gracilis feeds on various small chironomid midges. Malloch (1915) and de Meillon (1936) reported that the Notata Group holding their wings when at

rest. Edwards (1926) and Malloch (1915) reported finding the same habit in the Subviridis Group. The larvae are commonly found in mud and algae along pond margins (Thomsen, 1937). In West Africa, Ingram and Macfie (1921) reported two species from Pistia in a swamp. Johannsen (1932) and Mayer (1934) reared the larvae of perspicua in hot springs and in a rice field in Sumatra.

This genus is readily recognized by having female claws large and very unequal or a single long claw with barb; fourth tarsomere cordiform; first tarsomere of mid legs with subbasal spur; wing with second radial cell much longer than first which may be entirely absent.

Subgenus Stilobezzia s. str.

Members of this subgenus are characterized by the following characters: wing with two radial cells, without macrotrichia. Most of the species are described from the tropical region.

Illustration: Fig. 52 Stilobezzia (Stilobezzia) festiva K.

Subgenus Eukraiohelea Ingram and Macfie, 1921

Subgenus type: Eukraiohelea africana I. & M. (Macfie, 1940a)

Johannsen (1934) placed Eukraiohelea as a subgenus of Parabezzia Malloch (1915), but in comparing the male genitalia of Parabezzia petiolata Malloch 1915, with those of the four species of Eukraiohelea, the latter are more closely related to Stilobezzia.

This subgenus is characterized by having one radial cell on wing; vein R_1 arising at or past r-m; legs with stout spines on fore femur midventrally or at base.

Illustrations: Fig. 53 Stilobezzia (Eukraiohelea) elegantulata (Joh.)

Subgenus Neostilobezzia Goetghebuer, 1934

Subgenus type: Ceratopogon ochraceus Winnertz, 1852 (Wirth 1953a)

Goetghebuer (1934) distinguished this subgenus from Stilobezzia by the presence of macrotrichia at the end of the wing. In addition, all the species known are yellowish or brown to black, and the male genitalia with aedeagus bent and humped in the middle and basistyle without inner lobe. Most of the species are described from the temperate region.

Illustration: Fig. 54 Stilobezzia (Neostilobezzia) lutea (Malloch).

Key for the Subgenera of Stilobezzia

1. Wing with one radial cell (Fig. 53E); legs with spines on
fore femora; hind femora slender and unarmed (Fig. 53G)
. Eukraiohelea (Fig. 53)
- Wing with two radial cells; femora unarmed 2
2. Wing entirely bare of macrotrichia (Fig. 52E)
. Stilobezzia (Fig. 52)
- Wing with macrotrichia on the surface or at tip
(Fig. 54E) Neostilobezzia (Fig. 54)

Genus Echinohelea Macfie

Echinohelea Macfie, 1940, Proc. R. Ent. Soc. Lond. (B) 9:187; Wirth, 1951, Proc. Ent. Soc. Wash. 53:319; de Meillon, 1959, Novos Taxa Ent. 13:15; 1960, J. Ent. Soc. S. Afr. 23:409; Tokunaga, 1963, Pacif. Ins. 5:231. (Type-species: Echinohelea ornati-pennis Macfie, orig. desig.).

DIAGNOSIS. Eyes bare. Antennae of female with segments 11-15 elongated, the last segment usually shorter than the preceding four segments. Male antennae without plumose hairs. Thorax without anterior tubercle or spine, but with few stout bristles. Wing without macrotrichia, costa long, not extending beyond R_5 , M_1 and M_2 forked before or at r-m, two radial cells present; second one well developed. Femora of all legs not greatly swollen, almost all femora and tibia armed with long spines, scattered rather irregularly; fourth tarsal segment short, not distinctly bilobed or cordiform, fifth segment very long, slender, unarmed, claws equal or unequal, each with barb. Abdominal tergites of female without gland rods. Male genitalia: ninth sternite excavated mesally, basistyles large, dististyle small and slender, aedeagus arched, ending in two parts, each bearing hook; paramere fused mesally, expanded ends.

Approximately 11 species have been described.

Distribution: British Guiana, Liberia, New Britain, New Guinea, Upper Volta, and U.S.A. (Florida and Virginia).

This genus was reported by Macfie (1940b) for three very similar species from British Guiana. They resemble in general appearance some species of Serromyia but hind femora not greatly swollen. The distinctive characters of the genus are as follows: all femora and tibiae

armed strongly with well developed spines; last antennal segment always distinctly short. The male is readily recognized by having no plumes on antennae.

Illustration: Fig. 55 Echinohelea lanei Wirth

Genus Monohelea Kieffer

Monohelea Kieffer, 1917, Ann. Mus. Nat. Hung., 15:294; Goetghebuer, 1920, Mem. Mus. Roy. Hist. Nat. Belg., 8:63; Ingram and Macfie, 1921, Ann. Trop. Med. & Parasit., 15:344; Edwards, 1926, Trans. Ent. Soc. London, 74:410; Tokunaga, 1940, Tenthredo, 3:156; Johannsen, 1943, Ann. Ent. Soc. Amer., 36:781; Lane, 1948, Arg. Fac. Hig. Saude Pub. Univ. Sao Paulo, 1:225; Wirth, 1953, Proc. U. S. Nat. Mus., 103(3320):136; Tokunaga and Murachi, 1959, Ins. Micon., 12(3):404; Clastrier, 1963, Arch. Inst. Pasteur Algerie, 41:55; Tokunaga, 1963, Pacif. Ins., 5:238; Lane and Wirth, 1964, Studia Ent. (N.S.) 7:211; Wirth and Williams, 1964, Ann. Ent. Soc. Amer., 57:302. (Type-species: Monohelea hieroglyphica Kieffer, orig. desig.)

Schizohoelea Kieffer, 1917, Ann. Mus. Nat. Hung., 15:295; 1918, Ann. Mus. Nat. Hung., 16:57; 1919, Ann. Mus. Nat. Hung., 17:89; Goetghebuer, 1920, Mem. Mus. Roy. Hist. Nat. Belg., 8:65; Edwards, 1926, Trans. Ent. Soc. London, 74:411; Johannsen, 1943, Ann. Ent. Soc. Amer., 36:782 (Type-species: Ceratopogon leucopeza Meigen, as Ceratopogon copiosus Winnertz, mon.)

Allohelea Kieffer, 1917, Ann. Mus. Nat. Hung., 15:364 (Type-species: Sphaeromyas pulchripennis Kieffer, orig. desig.).

DIAGNOSIS. Body short, moderately hairy. Eyes bare or with very fine pubescence. Humeral pits inconspicuous. Fore and mid legs simple, fourth tarsal segment short, cylindrical, claws large or small but equal in both sexes; hind legs with thickening of femora and tibiae, spines absent; ventral of basitarsi with a spine at base, with or without spine at tip; fifth tarsal segment of female with one long claw and with or without another short one; hind claws of male small and equal except in some species; empodium absent. Wing with few macrotrichia at the tip; costa long; two radial cells, second cell well developed; intercalary fork inconspicuous; media with short stem, M_2 sometimes interrupted near base. Two spermathecae present. Male genitalia with bilobed or truncated ninth tergite; ninth sternite convex mesally; aedeagus usually with a pair of lateral sclerites and an additional dorsomedian lobe; parameres fused or paired.

Approximately 93 species have been described.

Distribution: World-wide.

The habits of Monohalea are unknown. The larva of only one species, M. calcarata, has been found in moss in a spring habitat (Strenzke, 1950).

The males of this genus are easy to identify by characters of the male genitalia but the great variation among the females makes identification very difficult. Wing markings are not a reliable character. Leg markings are more constant.

This genus resembles Stilobezzia but differs particularly in having the fourth tarsomere cylindrical, the female claws with the four anterior claws equal but the hind claw single and long.

Subgenus Monohalea s. str.

This subgenus is distinguished by the following characters:
 wing usually with pattern, first radial cell complete, base of M_2
 narrowly interrupted; scutum with pruinose pattern.

Illustration: Fig. 56 Monohalea (Monohalea) hieroglyphica K.

Subgenus Schizohalea Kieffer, 1917

Subgenus type: Ceratopogon copiosus Winnertz (mon.) = leucopeza
 (Meigen).

Members of the subgenus are characterized by: wing without
 pattern, first radial cell complete, M_2 broadly interrupted at base;
 scutum polished black.

Illustration: Fig. 57 Monohalea (Schizohalea) leucopeza (Mg.)

Subgenus Isthmoalea I. & M., 1931

Subgenus type: Isthmoalea disjuncta I. & M.

This subgenus is characterized by having two radial cells
 separated for some distance by fusion of vein between them, first
 radial cell complete.

Subgenus Kiefferomyia Mayer, 1937

Subgenus type: Kiefferomyia gorana Mayer

This subgenus differs from the other subgenera by having first
 radial cell obliterated.

Key for the Subgenera of Monohalea

1. First radial cell obliterated Kiefferomyia
 First radial cell complete 2
2. Fourth tarsomere cordiform or bell-shaped Isthmohelea
 Fourth tarsomere cylindrical or subcylindrical 3
3. Wing usually with pattern; M_2 not broadly interrupted
 at base (Fig. 56D) Monohalea (Fig. 56)
 Wing without pattern; M_2 broadly interrupted at
 base (Fig. 57D) Schizohalea (Fig. 57)

Genus Serromyia Meigen

Serromyia (Megerle, M. S. in) Meigen, 1818, Syst. Besch. Eur. Zweifl.

Ins., 1:83; Johannsen, 1905, Bull. N. Y. State Mus., 86:108;
Kieffer, 1906, Gen. Insectorum, fasc. 42:64; Johannsen, 1908,
Bull. N. Y. State Mus., 124:269; Malloch, 1914, Bull. Ill. State
Lab. Nat. Hist., 10:216; 1915, Bull. Ill. State Lab. Nat. Hist.,
10:331; Kieffer, 1917, Ann. Mus. Nat. Hung., 15:294; 1919,
Ann. Mus. Nat. Hung., 17:69; Goetghebuer, 1920, Mem. Mus. Roy.
Hist. Nat. Belg., 8:70; Edwards, 1926, Trans. Ent. Soc. London,
74:409; Tokunaga, 1940, Tenthredo, 3:156; Johannsen, 1943,
Ann. Ent. Soc. Amer., 36:781; Kettle and Lawson, 1952, Bull.
Ent. Res., 43:465; Claustrier, 1963, Arch. Inst. Pasteur Algerie,
41:60. (Type-species: Ceratopogon femoratus Meigen, mon.)

Prionomyia Stephens, 1829, Cat. Brit. Inst., 2:237 (Type-species:

Ceratopogon femoratus Meigen, desig. Westwood, 1840).

Ceratolophus (part) Kieffer (not Barboza de Bocage, 1873), 1899,

Bull. Soc. Ent. France, p. 69 (Type-species: Ceratopogon femoratus
Meigen, mon.).

Johannseniella Williston, 1907, Jour. N. Y. Ent. Soc., 15:1 (nom. nov.

for Ceratolophus K., not Barboza de Bocage).

DIAGNOSIS. Body slender and almost bare. Eyes bare. Female antennal
segments 3-10 short, segments 11-15 cylindrical and elongated; male
antennae plumose. Mesonotum covered with small bristles, humeral
pits absent. First four legs slender, without spines; fourth segments
of tarsi cordate, claws simple and almost equal; femora of hind legs
distinctly swollen in both male and female, armed ventrally with

numerous spines, tibia slender and curved basally; fourth segments of tarsi cylindrical, female claws highly unequal, without empodium. Wings with microtrichiae, macrotrichiae present in some species; costa long; two subequal radial cells present; intercalary fork absent, media sessile to short petiolate. Two spermathecae. Male genitalia: ninth sternite small; ninth tergite cone-shaped, with large anal lobes; basistyles stout, dististyles long and narrow; aedeagus small with long arms; parameres small and simple.

Approximately 27 species have been described.

Distribution: North America, Europe, Africa, Malaysia and Caroline Island.

The larval and pupal stages of S. femorata were given in Kettle and Lawson (1952).

LARVA. Large eyes. Two combs on epipharynx and each armed with a slender lateral plate; seven teeth on each half of dorsal; and 11 teeth on ventral side. No pigment, only a pair of grey and clear latiral substances in mesothorax and metathorax.

PUPA. Operculum thickly covered with nodules. Respiratory horn short, pale at base. Tip and distal area with eight or nine papillae. Metathorax concave. Arrangement of setae differs from Culicoides. Caudal spines dark at tips.

Larval habitat: Strenzke (1950) reported finding the larvae of S. femorata in damp moss in Germany.

Female claws resemble Heteromyia but the main point of difference is that the femur of hind leg is greatly swollen and armed, fore tibia arcuate. This character is found on fore leg of Heteromyia.

Illustration: Fig. 58 Serromyia femorata (Mg.)

Genus Macruröhelea Ingram and Macfie

Macruröhelea Ingram and Macfie, 1931, Dipt. Patag. and S. Chile,
part II, fasc. 4:203; Lee, 1962, Proc. Linn. Soc. N.W.W., 87:
339; Wirth, 1965, Pan-Pacif. Ent., 41:46. (Type-species:
Macruröhelea caudata Ingram and Macfie, orig. desig.).

DIAGNOSIS. Eyes well separated, with fine pubescence. Palpi five-segmented. Antennae with all segments short. Legs slender, without spines. Female claws small and equal. Wing without macrotrichia, microtrichia present; costa long; two radial cells present. Female abdomen with modified tenth segment, which curves forward and reaches the ventral side of the anterior segments. Spermathecae two or three. Male genitalia: with aedeagus Y-shaped, parameres separated, long but larger at the distal portion, basal arms well developed.

Approximately five species have been described.

Distribution: South America and Australia.

Ingram and Macfie, 1931, proposed this genus for two species, M. caudata I. & M. from southern Chile, and M. thoracica I. & M. from southern Argentina. The female of this genus is readily recognized by the uniquely modified abdomen, with the tenth segment long and bent forward and appressed to the venter of the preceding segment.

The wing venation and male genitalia are similar to Stilobezzia but differ in having equal tarsal claws. This character also separates them from Monöhelea. Macruröhelea can be separated from Echinohelea Macfie and Serromyia Meigen by the absence of femoral spines; and from Parabezzia Malloch by the presence of two radial cells.

Illustration: Fig. 59 Macruröhelea setosa Wirth

Genus Parabezzia Malloch

Parabezzia Malloch, 1915, Bull. Ill. St. Lab. Nat. Hist., 10:358;

Johannsen, 1943, Ann. Ent. Soc. Amer. 36:782; Wirth, 1952,

Proc. Ent. Soc. Washington 54:23; 1965, Proc. Ent. Soc. Wash-

ington 67:215. (Type-species: Parabezzia petiolata Malloch, orig. desig.)

Diaphanobezzia Ingram and Macfie, 1931, Dipt. Patagonia & S. Chile,

pt. 2, p. 223. (Type-species: Diaphanobezzia pellucida Ingram and Macfie, by orig. desig.).

DIAGNOSIS. Body rather stout, almost bare. Eyes bare. Palpus four-segmented with one to six long sensillae, first and second segments fused. Female antennal segments 3-10 oval, segments 11-15 cylindrical and elongated; male antennae plumose. Mesonotum without any sign of pits or spine or tubercle, but bristles and small pubescence present. Legs slender with some bristles; coxae of male densely covered with bristles; tarsi sometimes with ventral spines; fourth segments of tarsi cordiform; fifth segments swollen and flattened on the lateral side, sometimes with tubercles on ventral side; without empodium; male claws small and equal but long, curved and may be unequal in female; no basal tooth. Wing of male narrower than female, macrotrichia absent, microtrichia very fine; costa very long, extended beyond a single radial cell, costa shorter in male; median fork petiole. Spermathecae two. Male genitalia, aedeagus large, triangular, parameres small, fused to form triangular sclerite behind aedeagus.

Approximately 18 species have been described.

Distribution: North America, South America, Republic of Congo, Jamaica, and Puerto Rico.

PUPA. Pupa with very short respiratory horn, oval shape, about five pairs of spiracles; caudal spines short and stout, pointed laterally.

Adult habits: reared from sand bar (Wirth, 1965c)

Malloch (1915a) proposed the genus Parabezzia for three Nearctic species: P. petiolata n. sp. (male), Ceratopogon inermis Coquillett, and Bezzia elegantulata Johannsen. He used their petiolate media of wing as a distinguishing character.

It resembles Neurohelea in having long costa, extending beyond R_5 but differs in having one radial cell and four segmented palps.

Illustration: Fig. 60 Parabezzia petiolata Mall.

Genus Clinohelea Kieffer

Clinohelea Kieffer, 1917, Ann. Mus. Nat. Hung., 15:295, 316; 1919, Ann. Mus. Nat. Hung., 17:76; Goetghebuer, 1920, Mem. Mus. Roy. Hist. Nat. Belg., 8:76; Edwards, 1926, Trans. Ent. Soc. London, 74:413; Johannsen, 1931, Arch. f. Hydrobiol., 9:435; Macfie, 1934, Ruwenzori Exp., 351:91; 1939, Rev. Ent. Rio de J., 10:205; Johannsen, 1943, Ann. Ent. Soc. Amer., 36:783; Lane, 1944, Rev. Ent. Rio. de J., 15:249; Goetghebuer, 1948, Explor. Parc. Nat. Albert. Miss. de Witte fasc. 55:17; Lee, 1948, Proc. Linn. Soc. N.S.W., 73:64; Wirth, 1951, Proc. Ent. Soc. Wash., 53:321; 1952, Univ. Calif. Publ. Ent., 9:209; Lane & Durat, 1954, Dusenla, 5:247; de Meillon, 1959, Novos Taxa Ent. no. 13:20
(Type-species: Ceratopogon variegatus Winnertz, orig. desig.)

DIAGNOSIS. Eyes bare, widely separated. Palpi simple. Female antennal segments 3-10 long, segments 11-15 cylindrical. Humeral pits absent, anterior spine very short. Femora slender, without spines; fourth tarsal segment of at least four posterior legs strongly bilobed and each lobe terminates in a stout spine, fifth tarsal segment of fore legs greatly swollen in both male and female; claws of four posterior legs very unequal in female. Wing long, without macrotrichia; costa long; two radial cells well developed; intercalary fork absent; media widely sessile. Gland rods absent. Spermathecae two. Male genitalia: ninth sternite short; ninth tergite tapered; basistyles slender; dististyles very long and slender; aedeagus arched, median portion large; parameres slender, rounded tip and sometimes fused at particular point.

Approximately 26 species have been described.

Distribution: World-wide.

For the immature stages of Clinchelea, Wirth (1951d) published on the pupa. One species was collected from the sandy edge of a stream at Falls Church, Virginia.

PUPA. Light brown; long and slender respiratory organ with 10 spiracles at apex; operculum as long as broad, with a pair of round tubercles each with a long seta, surface especially near distal areas and between the tubercles with shagreen body surface appearance with crescent-shaped tubercles, sharp and setose at lateral margins; anal segment long with fine shagreening, the apicolateral processes well developed with sclerotized tip, subapical shagreening.

This genus differs from Palpomyia and Tetrabezzia in the following characters: fifth tarsomeres of fore legs swollen in both sexes; fourth tarsomeres of the four posterior legs of female highly bilobed, each with a stout spine; claws of four posterior legs of female very unequal.

The other characters which readily differentiate them from Tetrabezzia are: hind leg not unusually long; claws unequal only on four posterior legs; wing with two radial cells.

Illustration: Fig. 61 Clinohalea bimaculata (Loew)

Genus Tetrabezzia Kieffer

Tetrabezzia Kieffer, 1917, Ann. Mus. Hung., 15:296; Ingram and Macfie,

1923, Bull. Ent. Res., 14:70; Macfie, 1940, Ann. Trop. Med.

Parasit., 34:24; de Meillon, 1961, Rev. Ent. Mocambique, 4:55;

Wirth, 1962, Ann. Ent. Soc. Amer., 55:274. (Type-species:

Tetrabezzia spinigera Kieffer, mon.)

DIAGNOSIS. Large size, body slender and almost bare. Eyes bare, separated. Female antennae very long and slender with very long hairs on segments 3-10; palpi slender, third segment simple. Mesonotum with anterior spine. Legs long, hind legs longest, hind femur enlarged near tip, fourth tarsomeres with bifid spinose lobes on fore and mid legs, but long and cylindrical on hind legs; bifid lobes of male fourth tarsomeres not as distinct as in female; claws very unequal on female, almost subequal on male; fore femur armed ventrally. Abdomen petiolate, two spermathecae, gonopore without hair tufts. Wing infusate, macrotrichia absent, microtrichia fine, costa almost

reaches the wing tip. Male genitalia with ninth sternite short, ninth tergite large, basistyles and dististyles long and slender, aedeagus arch, triangular shape, parameres club-tipped.

Approximately four species have been described.

Distribution: Africa, Malaya, Thailand.

This genus resembles Clinohalea but the chief points of difference are as follows: female hind leg unusually long; fourth tarsomere of four anterior legs with bifid spinose lobes; all female claws very unequal; wing with one radial cell; abdomen petiolate.

Illustration: Fig. 62 Tetrabezzia pictipennis (K.)

Genus Heteromyia Say

Heteromyia Say, 1825, Amer. Ent., 2:79; Kieffer, 1906, Gen. Insectorum, fasc., 42:64; Edwards, 1926, Trans. Ent. Soc. London :420; 1935, Konowia, 12:87; Macfie, 1940, Ann. Trop. Med. Parasit., 34:27; Johannsen, 1943, Ann. Ent. Soc. Amer., 36:774; Lane, 1946, Rev. Ent. Rio de J., 17:211; Lee, 1948, Proc. Linn. Soc. N.S.W., 73:61; Duret and Lane, 1955, Dusenla, 6:35; Lane, 1961, Rev. Bra. Biol., 21:41, Wirth, 1962, Ann. Ent. Soc. Amer., 55:274.
(Type-species: Heteromyia fasciata Say, mon.).

Pachyleptus Walker, 1856, Insecta Saundersiana, Diptera. London :426.

DIAGNOSIS. Large size, body slender with few hairs. Eyes bare, broadly separated. Female antennal segments 3-10 long, segments 11-15 very long and dark; male antennae with inconspicuous plumes. Palpi long and slender, third segment simple. Mesonotum dark; with small anterior spine. All legs different, femora of fore legs greatly swollen and armed ventrally with spines, fore tibiae arched along

the femora; mid legs long; hind legs of female very long, tip of hind femora club-shaped; fourth tarsal segments on all legs of male and on the anterior four of female cordate, but long and slender on hind legs of female. Hind claws of female single, very long and barbed basally; the others including all male claws equal. Wing fasciate, with one or two radial cells; costa long. Male genitalia: ninth sternite short, ninth tergite tapering with well developed apicolateral process; basistyles and dististyles simple; aedeagus arched with large body; parameres club-tipped and lateral arms distinct.

Approximately 20 species have been described.

Distribution: North America, South America, Asia, and Australia.

The study of the immature stages was made by Thomsen (1937).

One pupa was found from wet algae on the cliffs near Ithaca, New York.

PUPA. Respiratory trumpet flat and short, constricted at base, apex bearing 11 spiracles; operculum with two setae and also with small hooks scattered on the surface; abdominal segments with three mid dorsal sclerotized areas, the surface beside these areas covered with small round hooks; last segments with two projections.

This genus is closely related to Palpomylia and some authors have misplaced them in Palpomylia. It is differentiated from Palpomylia by the following characters: fore femur greatly swollen and armed ventrally with spines; fore tibia arcuate to the shape of the femur; hind leg of female very long with a single barbed claw; fourth tarsal segment on all legs of male and anterior four of female cordate, with equal claws; wing fasciate.

In Serromyia, hind femur is greatly swollen and armed and tibia also arcuate as in fore leg of Heteromyia.

Illustration: Fig. 63 Heteromyia fasciata Say, Heteromyia sp.

Genus Pellucidomyia Macfie

Pellucidomyia Macfie, 1939, Ruwenzori Exped., 1934-5, 1(5):99;

Wirth, 1960, Bull. Brooklyn Ent. Soc., 55:1 (Type-species:

Pellucidomyia ugandae Macfie, mon.)

Macfiehelea Lane, 1946, Rev. de Ent. , 17:208 (Type-species:

Macfiehelea oliveirai Lane, Mon.); Lane, 1956, Rev. Brasil.

Biol. 16:435 (key to 3 Neotropical spp.)

DIAGNOSIS. Dorsal side of the body covered thickly pollinose with dark and white areas. Head with anterior and posterior portions flattened; eyes widely separated; antennae usually elongated; palpi five-segmented, all segments simple, third segment with sensory pit absent. Mesonotum without spine or tubercle but with anterior cone. Legs slender, without spines in all femora, distal part almost club-like; hind legs longest; fourth tarsal segment cylindrical and elongate, but cordiform to transverse on the first fore legs; fifth segment unarmed, simple on mid and hind legs, enlarged on fore legs; claws on fore and mid legs short and equal, hind leg with single and long claw. Wing without macrotrichia or microtrichia; one radial cell present; costa long. Abdomen with two tufts of long hairs on ventral side of the eighth segment; spermathecae two; abdomen slightly curved downward. Male with all claws equal, hind leg simple not as long as in female; wing long and narrow; antennae with few plumes; male genitalia with ninth sternite small, ninth tergite tapered, basistyles simple, dististyles rather stout with curved, pointed tips, aedeagus arched sides almost parallel, parameres separated and reduced.

Approximately five species have been described.

Distribution: Panama, Brazil, Uganda, Australia, Colombia, and Mexico.

The character of the unarmed fifth tarsomere and unusually long hind leg closely relate this genus to the genera Clinohelea Kieffer, Tetrabezzia Kieffer, and Heteromyia Say. It is readily separated from Heteromyia and Tetrabezzia by having fore femora unarmed. It differs from Clinohelea particularly in having a cordiform to cylindrical fourth tarsomere not strongly bilobed as in Clinohelea. The wing venation is similar to Neurohelea and Parabezzia with the long costa extending well beyond R_5 while Bezzia has similar venation without extension of costa, all these genera have one radial cell, five-segmented palpi.

Illustration: Fig. 64 Pellucidomyia sp.

Genus Neurohelea Kieffer

Neurohelea Kieffer, 1925, Faune de France, 11:112; Edwards, 1926, Trans. Ent. Soc. London, 74:413; Ingram and Macfie, 1931, Dipt. Pat. & S. Chile, pt. 2, fasc. 4:212; Johannsen, 1943, Ann. Ent. Soc. Amer., 36:783; Wirth, 1952, Univ. Calif. Publ. Ent., 9:208.

(Type-species: Ceratopogon luteitarsis Meigen, mon.)

DIAGNOSIS. Moderate size, body almost bare. Eyes bare and separated. Female antennal segments 3-10 oval with sparse verticils, segments 11-15 cylindrical and elongated. Male antennae with few plumes; palpi slender, third segment not swollen. Mesonotum without anterior tubercle. All femora slender and unarmed; fifth tarsal segment of

fore tarsi swollen in both sexes. Wings moderately broad; macrotrichia absent; costa extending much beyond R_5 ; two well developed radial cells; intercalary fork absent; median fork barely sessile or with very short stem. Female abdomen without eversible glands or gland rods. Two spermathecae. Male genitalia: ninth sternite small, transverse, with continuous spiculate membrane from ventral face of aedeagus to apex; ninth tergite narrow, tapering with a pair of well developed setose lobes; basistyles and dististyles stout; aedeagus a sclerotized arch with rounded apex and parallel sides; parameres with a pair of flattened plates distally.

Approximately five species have been described.

Distribution: North America and South America.

Characters are as in Palpomyia with these exceptions: anterior tubercle absent; all femora slender and unarmed; last segment of fore tarsi swollen in both sexes; costa extended beyond R_5 ; median fork barely sessile or with very short stem; female abdomen without eversible glands.

In Parabezzia wing with costa extended beyond R_5 as in Neurohelea but only one radial cell present; fifth tarsomere swollen. Neurohelea with two radial cells on wing.

Illustration: Fig. 65 Neurohela nigra Wirth

Genus Johannsenomyia Malloch

- Johannsenomyia Malloch, 1915, Bull. Ill. State Lab. Nat. Hist., 10:332; Goetghebuer, 1920, Mem. Mus. Roy. Hist. Nat. Belg., 8:73; 1921, Mem. Mus. Belg. 8 fasc. 4:182; Edwards, 1926, Trans. Ent. Soc. London, 74:413; Ingram and Macfie, 1931, Dipt. Patag. & S. Chile, pt. 2:231; Johannsen, 1931, Arch. f. Hydrobiol., Suppl., 9:435; Goetghebuer, 1933, Rev. Zool. Bot. Afr. 24:149; 1938, Bull. Ann. Soc. Ent. Belg., 78:380; Macfie, 1940, Proc. Roy. Ent. Soc. London, (B) 9:75; Johannsen, 1943, Ann. Ent. Soc. Amer., 36:784; Wirth, 1952, Univ. Calif. Publ. Ent., 9:210; Clastrier, 1962, Arch. Inst. Pasteur Alger., 40:282; Wirth, 1962, Ann. Ent. Soc. Amer., 55:276; 1965, Proc. Ent. Soc. Wash., 67:4. (Type-species: Johannsenomyia halteralis Malloch, designated in Wirth, 1952, Univ. Calif. Publ. Ent., 9:211 = argentata (Loew).
- Dicrohelea Kieffer, 1917, Ann. Mus. Natl. Hung., 15:363. (Type-species: Palpomyia filicornis Kieffer (des. Macfie, 1940, Ann. Trop. Med. Parasitol., 34:26).

DIAGNOSIS. Body slender, almost bare. Eyes bare and contiguous below. Female antennae elongated, male antennae plumose. Palpi slender. Mesonotum with anterior tubercle; with microtubercles bearing short setae over the surface. Legs long and quite slender; femora especially of hind legs enlarged near apices; no spines on femora or tibia; fourth tarsal segment simple; fifth segment with very blunt batonnets on the ventral side, numerous in female but only two to three pairs in male. Female claws highly unequal on four posterior legs, fore legs with equal claws; all claws each with external basal tooth; male claws simple, inconspicuously bifid at tip.

Wings with short costa, two radial cells. Abdomen narrower near base, hair tufts present near gonopore; spermathecae two. Male genitalia rotated; ninth tergite rounded with strong bristles near posterior margin; aedeagus arched, body large, with caplike tip; parameres paired with large platelike tip.

Approximately 18 species have been described.

Distribution: North America, South America, Europe, Asia, and Africa.

Information on the immature stages is presented in Malloch (1914), Thomsen (1937), Johannsen (1952), Wirth (1952), Wirth and Stone (1956) and Wirth (1962a).

EGG. Thomsen (1937) indicated that eggs of two unknown species and J. argentata (Lw.) were arranged in more or less spiral bands, eggs of the latter were found at the edge of a pond in New York.

LARVA. The first instar larva has a long, conical head and anal segment with four long hairs and four slightly shorter hairs.

PUPA. The respiratory horn is very short; abdominal tubercles are small, not conical or angulate; granular discs on abdominal sterna are absent (Wirth, 1962a). The pupa of J. sybleae was described by Wirth (1952); it was taken from a cattail-choked pond near the beach. Malloch (1914a) also described the pupa of J. flavidula taken from the Illinois River.

Williston (1907) proposed the new name Johannseniella to replace the former genus Ceratolophus Kieffer (1899) which was preoccupied by Ceratolophus Barbosa de Bocage (1873). Malloch (1915a) noticed that the genotype, Ceratopogon femoratus (Fabricius) was also being used as the genotype of Serromyia Meigen (1819). In this new revision,

he divided the species into two groups under two new genera.

Johannsenomyia was proposed for those with media sessile. The type species was not designated until Wirth (1952) utilized the characters of the allotype female and designated Malloch's last species J. halteralis (male) as genotype.

After careful study, Wirth (1962a) suggested that this genus must have a new name since Malloch (1915) had misplaced the female of the type species halteralis in a different genus.

Johannsenomyia is related to Jenkinshelea, Mallochohelea, Milobezzia, Sphaeromyias, Xenhelea, Probezzia, and Calyptopogon in having batonnets on fifth tarsomere but the following distinctive characters of the genus can be differentiated from the others: hind leg enlarged especially near knee; femora unarmed; claws highly unequal on four posterior legs, each claw with external basal tooth; ventral hair tufts present on eight abdominal segment and wing simple with two radial cells.

Illustration: Fig. 66 Johannsenomyia argentata (Loew)

Genus Xenhelea Kieffer

Xenhelea Kieffer, 1917, Ann. Mus. Nat. Hung., 15:295; Macfie, 1934, Tijdschr. Ent., 77:226; Macfie, 1940, Ann. Trop. Med. Parasit., 34:28; de Meillon, 1942, Estac. anti-Malar. Lourenco Marques :23; Lee, 1948, Proc. Linn. Soc. N. S. W., 73:65; Mayer, 1957, Dtsch. Ent. Z. (N. F.), 4:31. (Type-species: Xenhelea pruinosa Kieffer, orig. desig.)

Mixhelea Kieffer (1917).

DIAGNOSIS. Body slender, almost bare. Eyes bare, nearly contiguous. Palpi slender, all segments simple. Female antennal segments 3-10 oval, segments 11-15 very long. Mesonotum sometimes with a spine at mid anterior portion. Wing without macrotrichia, costa long, two well developed radial cells present. Legs slender, hind legs slightly longer than the preceding legs, femora sometimes with a few spines; fourth tarsal segments cylindrical; fifth segments armed with very stout, distally bent batonnets. Female with single long claw with basal barb on all legs.

Male unknown.

Approximately six species have been described.

Distribution: Africa, Asia, and Australia.

PUPA. Mayer (1957) described the pupa of Xenohalea galatea de Meillon: prothoracic horn with about nine spiracles; operculum absent; two long setae on prothoracic horn; three to seven abdominal segments with most tubercles surrounded by a round chitin edge; exuviae dark.

This genus has most of the characters of Palpomyia but all claws are unequal and simple and the fifth tarsomere is armed with batonnets. It is particularly differentiated from Jenkinshelea, Johannsenomyia, Mallochohelea, Nilobezzia and Sphaeromyias, those genera bearing batonnets on fifth tarsomere but the batonnets of Xenohalea are located only on the anterior half of the segment.

Illustration: Fig. 67 Xenohalea tonnoiri Lee

Genus Jenkinshelea Macfie

Jenkinshelea Macfie, 1934, Ann. Trop. Med. Parasit., 28:177; de Meillon, 1936, Pub. S. Afr. Inst. Med. Res., 38:189; 1937, Ann. S. Afr. Mus., 32:261; Johannsen, 1942, Ent. News, 53:76; de Meillon, 1942, Proc. Rhod. Sci. Ass., 39:116; 1943, J. Ent. Soc. Sthn. Afr., 6:109; Johannsen, 1943, Ann. Ent. Soc. Amer., 36:774; Mayer, 1952, Beitr. Ent., 2:584; Wirth, 1962, Bull. Brooklyn Ent. Soc., 57:2 (Type-species: Jenkinshelea setosipennis (Kieffer)).

DIAGNOSIS. Body slender. Eyes broadly separated. Male antennae with few plumes. Mesonotum with fine whitish gray pubescence. Anterior portion of thorax somewhat jutting over the head but not pointed. Legs slender, femora unarmed; fourth tarsal segment wider than long, cordate or bell-shaped; fifth tarsomere with strong ventral batonnets; tarsal claws equal on all legs, each with external basal tooth. Wing with unusually broad anal lobe, one or two radial cells, costa extended mostly to wing tip, medial fork broadly sessile, posterior branch of media not elbowed in female; microtrichia present. Abdomen of female, eighth segment with sclerotization and pair of ventral hair tufts. Male genitalia, aedeagus stout, paramere very slender, separated at tip hooklike.

Approximately six species have been described.

Distribution: North America, South Africa, and India.

PUPA. Large, respiratory trumpet very small and oval-shaped with about 10 pairs of spiracles, caudal spines long, pointed posteriorly with about 60 degree apart from each other; abdomen with glandular discs present.

Kieffer (1913a) erected the new genus Jenkinsia for a species of midge taken in Calcutta. Since this name had been previously occupied by a genus of fishes, Macfie (1934b) suggested the name Jenkinshelea to substitute for it.

This genus resembles Johannsenomyia but can be readily separated from it in the characters of thorax and wing. The thorax of Jenkinshelea is somewhat projecting over the head and wing with enlarged anal lobe.

Illustration: Fig. 68 Jenkinshelea magnipennis (Joh.)

Genus Probezzia Kieffer

Probezzia Kieffer, 1906, Gen. Insectorum, fasc. 42:57; Coquillett, 1910, Proc. U. S. Nat. Mus., 37:594; Malloch (part), 1914, Proc. Biol. Soc. Wash., 27:137; Malloch (part), 1915, Bull. Ill. St. Lab. Nat. Hist., 10:352; de Meillon, 1942, Estac. anti-Malar. Lourenco Marques p19; Wirth, 1951, Proc. Ent. Soc. Wash., 53:27; (Type-species: Ceratopogon venustus Meigen, desig. Coquillett, 1910).

Microbezzia Kieffer, 1919, Ann. Mus. Nat. Hungariei, 17:127; Ingram & Macfie, 1921, Ann. Trop. Med. and Parasitol., 15:371; Edwards, 1926, Trans. Ent. Soc. London, 74:414; Johannsen, 1943, Ann. Ent. Soc. Amer., 36:785; Lane, 1947, Arq. Fac. Hig. S. Pub. U. Sao Paulo, 1:232. (Type-species: Ceratopogon venustus Meigen, orig. desig.).

DIAGNOSIS. Body slender and almost bare. Eyes bare and separated. Female antennal segments 3-10 short, globose, segments 11-15 long;

male antennae with few plumes. Mesonotum without anterior spine or tubercle; short bristles scattered on the surface. Legs slender, femora unarmed; fourth tarsomere broad and short; female fifth tarsomere with ventral batonnets; claws with blunt outer basal tooth. Wing usually milky white with obscure broad infuscated band; single radial cell well developed, vein R_2 missing; costa long; media widely sessile. Female abdomen with a pair of ventral hair tufts on eighth segment. Spermathecae two. Male genitalia: ninth sternite narrow and highly concave; ninth tergite long and tapering distally, lateral lobes well developed; basistyles elongate but dististyles small; aedeagus arched, tapered, ending in caplike tip; parameres fused with bifid tip.

Approximately 36 species have been described.

Distribution: World-wide.

Little information concerning the immature stages of Probezzia have been reported. The following statements are taken from Thomsen (1937).

EGG. Eggs of Probezzia glabra (Coq.) are long, narrow and arranged almost vertical in the mass.

LARVA. Larvae are similar to those of Bezzia, the head is oblong, three to four times as long as wide; anal hairs are varied in length. Flap-like structure inside of cast skin is absent.

PUPA. Pupae of Bezzia and Probezzia can be separated by the number of setae on operculum. They are also similar to those of Palpomyia and Heteromyia. Differences are in numbers of setae on operculum and numbers of respiratory spiracles on the trumpet. According to

Mayer (1937), the pupae of this genus cannot be separated from those of Johannsenomyia.

This genus resembles Bezzia by having slender unarmed femora; fifth tarsomere of female with ventral batonnets. Males differ from Bezzia males by the great prolongation of the radial cell.

The presence of a pair of ventral hair tufts on the eighth abdominal segment is similar to Nilobezzia, Jenkinshelea, Johannsenomyia and Mallochohelea. The presence of only one radial cell and simple anal lobe readily separates the genus from Jenkinshelea, Johannsenomyia and Mallochohelea. The male genitalia with well developed claspers differentiates Probezzia from Nilobezzia.
Illustration: Fig. 69 Probezzia pallida Malloch

Genus Calyptopogon Kieffer

Calyptopogon Kieffer, 1910, Mem. Ind. Mus., 2:209; Johannsen, 1927, Ent. Mitt., 16:423; Seguy, 1931, Bull. Soc. Ent. France, :208 1934, Mem. Acad. Cienc. Zaragoza, 3:10; de Meillon, 1936, Pub. S. Afr. Inst. Med. Res., 38:204; 1937, Pub. S. Afr. Inst. Med. Res., 40:351; 1938, Proc. R. Ent. Soc. Lond., (B) 7:270; Macfie, 1939, Trans. R. Ent. Soc. Lond., 89:2; de Meillon, 1940, Trans. R. Ent. Soc. Lond., 90:463; 1942, Proc. Rhod. Sci. Ass., 39:116; Mayer, 1952, Beitr. Ent., 2:584; Lane, 1961, Rev. Bras. Biol., 21: 37. (Type-species: Calyptopogon albitarsis Kieffer, mon.).
Haasiella Kieffer (1913), Macroptilum Becker (1903), Macropeza Meigen (1818).

DIAGNOSIS. Body large, very slender. Eyes bare, widely separated. Palpi short, rather pale; mandible teeth large. Female antennae greatly elongated. Male antennae with few plumes. Thorax conical shaped in front. Legs slender; first femora sometimes club-shaped distally; no spines on femora or tibiae; hind legs longest, hind femora and tibiae very long and slender; fourth and fifth tarsal segments of fore legs swollen; tarsomeres of mid and hind legs slender, fifth segment with three pairs of ventral batonnets; two pairs on fore legs; male fifth tarsomere without batonnets, claws small and equal, each with external basal tooth; male claws simple with cleft tip. Wing with one narrow radial cell, costa very long extended beyond R_5 , crossvein r-m very long and causing cell R_5 to appear broad. Abdomen elongated; eighth abdominal segment bearing two ventral hair tufts; two spermatheca. Male genitalia: basistyles slender, dististyles tapering; ninth sternite narrow and highly concave; ninth tergite tapering, lateral lobes well developed; aedeagus arched; parameres fused at base, tips elongated and slender.

Approximately 20 species have been described.

Distribution: South America, Europe, Asia, and Africa.

This genus is related to Stenoxenus but differs in the following points: hind leg very long; fifth tarsomere bearing batonnets; r-m crossvein long; vein M_2 not elbowed, thorax conical in front and ventral hair tufts present.

It resembles Tetrabezzia, Heteromyia, Pellucidomyia, and Clinohalea in having the unusually long hind leg, but differs in having batonnets on fifth tarsomeres.

The wing with costa prolonged beyond R_5 is similar to those of Neurobezzia and Parabezzia but the radial cell of Stenoxenus is very narrow and cell R_5 is wide.

Illustration: Fig. 70 Calyptopogon gibbosus (Wied)

Genus Sphaeromias Curtis

Sphaeromias (Stephens Ms, sine descr.) Curtis, 1829, Brit. Ent.,

6:285; Kieffer, 1906, Gen. Insectorum, fasc. 42:62; Edwards,

1926, Trans. Ent. Soc. London, 74:415; Johannsen, 1931, Arch.

f. Hydrobiol., Suppl., 9:436; 1943, Ann. Ent. Soc. Amer., 36:784;

Wirth, 1952, Univ. Calif. Publ. Ent., 9:214; Freeman, 1954, Arch.

Hydrobiol. 48:445; de Meillon, 1961, Rev. Ent. Mocambique, 4:54.

(Type-species: Sphaeromias albomarginatus Curtis (mon.) =

fasciatus (Meigen)).

Xylocrypta Kieffer, 1899, Bull. Ent. Soc. France, p. 69; 1917, Ann.

Mus. Nat. Hung., 15:295 (Type-species: Ceratopogon fasciatus

Meigen, mon.).

Schizodactylus Ingram and Macfie, 1921, Ann. Trop. Med. & Parasit.,

15:353 (Type-species: Schizodactylus talmatoscopus Ingram and

Macfie, mon.)

Ankistrodactylus Ingram and Macfie, 1922, Ann. Trop. Med. & Parasit.,

16:272 (new name for Schizodactylus Ingram and Macfie, not

Schizodactyla Claus, 1876, Coelenterata.)

DIAGNOSIS. Body large, very stout, almost bare. Eyes bare and very narrowly separated. Antenna long, almost bare, male antenna with few plumes. Palpi slender. Mesonotum densely pollinose, anterior tubercle poorly developed. Legs slender with numerous spines on ventral side of femora and dorsal side of tibiae. Fourth tarsal segment simple; fifth segment with numerous ventral blunt dark spines or batonnets; claws large, equal, each with long inner basal tooth. Wing with long costa, radial cells two. Spermathecae two. Male genitalia: basistyles and dististyles elongate; aedeagus arched, broad tip; parameres fused, lateral arms developed, distal part club-shaped.

Approximately 40 species have been described.

Distribution: North America, South America, Europe, Africa, and Asia.

PUPA. Respiratory trumpet long, apex wide and rounded, tapering basally; abdominal tubercle conspicuous, conical and pointed; abdomen with ventral glandular discs absent; caudal spines slender.

Members of this genus have the characters of Palpomyia, with the following exceptions: eyes very narrowly separated; antennae very short; anterior tubercle poorly developed or absent; femoral spines more numerous but smaller and inconspicuous; fourth tarsomere short, cylindrical; fifth tarsomere bearing batonnets, claws large and male antennae with very few plumes.

Subgenus Sphaeromias s. str.

Fifth tarsomere with three or more pairs of batonnets along the length of the segment.

Illustration: Fig. 71 Sphaeromias (Sphaeromias) longipennis (Loew)

Subgenus Homohoelea Kieffer, 1917

Subgenus type: Homohoelea abjuncta (Kieffer).

Fore femora slightly swollen; femora armed; tibiae unarmed, mid tibia sometimes with an apical ventral spine; fourth tarsomere slender oval; fifth segment with one or two pairs of basal batonnets.

Illustration: Fig. 72 Sphaeromias (Homohoelea) barkudensis (Edwards)

Key for the Subgenera of Sphaeromias

1. Fifth tarsomere with few batonnets located on the
basal half of segment (Fig. 72G) Homohalea (Fig. 72)
- . Fifth tarsomere with numerous batonnets along
the segment (Fig. 71K) Sphaeromias (Fig. 71)

Genus Mallochohelea Wirth

Mallochohelea Wirth, 1962, Ann. Ent. Soc. Amer., 55:278.

Johannsenomyia Malloch, misident.; Johannsen, 1943,

Ann. Ent. Soc. Amer., 36:784; Wirth, 1952, Univ. Calif.

Publ. Ent., 9:210; Johannsen, 1952, Connecticut State Geol.

Nat. Hist. Surv. Bull., 80:164. (Type-species: Johannsenomyia albibasis Malloch, orig. desig.).

DIAGNOSIS. Body slender or fairly stout, almost bare, integument shining. Eyes bare, broadly separated. Palpi slender; mandible teeth large. Female antennae rather long. Male antennae with few plumes. Anterior spine, and tubercle on mesonotum absent. Legs slender or enlarged; femora sometimes with few ventral spines; tibiae without spines; fourth tarsal segment simple; fifth segment with five to eight pairs of ventral batonnets; claws long and equal, each with blunt external basal tooth. Male claws simple with tip slightly cleft. Wing with two radial cells. Abdomen tapering and elongated posteriorly; eighth segment bearing two ventral hair tufts; spermathecae two. Male genitalia: basistyles elongated, dististyles slender and short, aedeagus arched, stout body, distal part tapering ending in caplike tip; parameres fused at base, separated anteriorly into a pair of long processes.

Approximately 21 species have been described.

Distribution: World-wide.

PUPA. Respiratory trumpet very short, about twice as long as broad; abdominal segments with conspicuous spinose tubercles, project posteriorly; sixth and seventh sternal segments with membranous glandular discs. (Wirth, 1962)

Wirth (1962a) erected this genus for the majority of Johannsenomyia which were misidentified by Malloch (1915).

Mallochochelea is closely related to Johannsenomyia and Jenkinshelea by the following characters: claws with external basal tooth; abdomen with a pair of ventral hair tufts on eighth segment, and wing with two radial cells. It is distinguished from Johannsenomyia by the equal tarsal claws in the female, absence of batonnets on the male fifth tarsomere, and absence of anterior tubercle. The wing with simple anal lobe can be readily separated from the wing of Jenkinshelea.

This genus also resembles Nilobezzia but the male genitalia with well developed claspers distinctly separates them.

Illustration: Fig. 73 Mallochochelea albibasis (Mall)

Genus Nilobezzia Kieffer

Nilobezzia Kieffer, 1921, Ann. Soc. Ent. France, 90:24; 1922, Ann.

Soc. Linn. Lyon, 68:161; Edwards, 1929, Notul. Ent., 9:12;

Macfie, 1939, Ruwenzori Exp., 1934-35, 1:101; de Meillon, 1943,

J. Ent. Soc. Sthn. Afr., 6:111; Lee, 1948, Proc. Linn. Soc. N.S.W.,

72:343; de Meillon and Hardy, 1954, J. Ent. Soc. S. Afr., 17:70;

Clastrier, 1958, Arch. Inst. Pasteur Alger., 36:498; Sen & Das

Gupta, 1958, Bull. Calcutta Sch. Trop. Med., 6:69; Lane, 1961,

Stud. Ent. (N.S.), 4:449; Clastrier and Wirth, 1961, Arch. Inst.

Pasteur Alger., 39:212; Clastrier, 1962, Arch. Inst. Pasteur

Alger., 40:121; Tokunaga, 1962, Pacif. Ins., 4:216; Wirth, 1962,

Ann. Ent. Soc. Amer., 55:284; Vattier and Adam, 1966, Ann.

Speleol., 21: 711. (Type-species: Nilobezzia armata Kieffer, mon.).

DIAGNOSIS. Body very stout, almost bare. Eyes bare, very narrowly separated. Antennae not elongated; male antennae with few plumes. Palpi slender; mandible with large teeth. Thorax densely pollinose, anterior tubercle absent. Legs slender; femora fairly stout, with stout bristles scattered on ventral side, tibia with bristles on dorsal side. Fourth tarsal segments simple; fifth segment with numerous ventral batonnets, claws large and equal, each with blunt external basal tooth. Wing with one or two radial cells; costa short. Abdomen with a pair of ventral hair tufts on eighth segment; spermathecae two. Male genitalia: basistyle and dististyle barely developed and fused forming a cone-like process; aedeagus with slender arch and caplike distal portion; parameres fused mesally, tip slender.

Approximately 26 species have been described.

Distribution: North America, South America, Africa, and Asia.

PUPA. Respiratory trumpet short, about three times longer than the distal portion; abdominal tubercles distinctly large, conical, pointed and directed caudad; glandular discs present on abdominal sternae five, six and seven in schwarzii (Coq.), but absent in minor (Wirth). (Wirth, 1962)

This genus is similar to Jenkinshalea, Mallochochelea and Johannsenomyia in having an external basal tooth on claws; eighth abdominal segment bearing a pair of ventral hair tufts. But it is readily separated from those three genera by the character of armed femora (subgenus Nilobezzia) which resembles Bezzia. However, the fourth tarsomere in all Nilobezzia is subcylindrical and the spines

on femora are not as well developed as in Bezzia. The male genitalia with reduced claspers is the unique character of Nilobezzia.

subgenus Nilobezzia s. str.

Femora armed ventrally with black spines.

Illustration: Fig. 74 Nilobezzia (Nilobezzia) schwarzii (Coq.)

Subgenus Parrotia Kieffer, 1924

Subgenus type: Parrotia flaviventris Kieffer

Femora unarmed.

Key for the Subgenera of Nilobezzia

1. Femora armed ventrally with black spines (Fig. 74 F)

..... Nilobezzia (Fig. 74)

Femora unarmed Parrotia

Genus Stenoxenus Coquillett

Stenoxenus Coquillett, 1899, Ent. News Philad., 10:61; Johannsen, 1927, Ent. News, 38:70; Seguy, 1931, Bull. Soc. Ent. Fr., p209; Macfie, 1934, Ann. Trop. Med. Parasit., 28:290; 1939, Rev. Ent. Rio de J., 10:138; 1940, Ann. Trop. Med. Parasit., 34:28; Johannsen, 1943, Ann. Ent. Soc. Amer., 36:774; Lane, 1956, Rev. Bras. Biol., 16:305; de Meillon, 1959, S. Afr. Anim. Life, 6:355; Lane, 1961, Stud. Ent. (N.S.), 4:452; Vattier and Adam, 1966, Ann. Speleol. 21:7//. (Type-species: Stenoxenus johnsoni Coquillett, mon.).

DIAGNOSIS. Moderate size, slender, dorsoventrally flattened. Eyes bare, widely separated. Female antennal segments 3-10 with stout setose hairs, segments 14-15 elongated with few hairs; male antennae with very few plumes. Palpi four-segmented, third segment slender. Mesonotum broad and round anteriorly without anterior tubercle. Femora unarmed, hind femur and tibia long and slender, vestiture with very fine erect hairs; first and second tarsomeres of hind leg with ventral tubercles; fourth tarsal segment spoon-shaped or sub-cylindrical; fifth segment unarmed; claws small and equal. Wing with r-m crossvein very short, causing the cell between vein R and M to appear narrow; costa long extended to the tip of wing; on radial cell; media sessile, in male forking at level of crossvein; M₂ elbowed in female. Female abdomen with pairs of eversible glands and gland rods. Male genitalia: ninth sternite small, ninth tergite short with well developed lateral lobes; basistyles slender, dististyles elongated; aedeagus with slender arch, pointed tip; parameres fused with broad rounded tip.

Approximately 12 species have been described.

Distribution: North America, South America, Africa, Malaysia, and Tonkin.

Related to Calyptopogon with the following exceptions: hind leg simple, not very long; fifth tarsomere without batonnets, wing with vein M_2 elbowed, r-m crossvein short; thorax not conical in front.

It also resembles Bezzia in the presence of gland rods on the female abdomen and the male parameres fused in one long lobe but it can be separated from Bezzia by the above mentioned characters.

The female of this genus is readily recognized by the wing with vein M_2 elbowed, this character is not found in other ceratopogonids..

Illustration: Fig. 75 Stenoxenus insigninervis Macfie

Genus Paryphoconus Enderlein

Paryphoconus Enderlein, 1912, Stett. Ent. Zeitg., 73:57; Kieffer, 1917,

Ann. Mus. Nat. Hung., 15:332; Macfie, 1939, Trans. Roy. Ent. Soc.

London, 89(1):1; 1939, Rev. Ent., 10:142; 1940, Ann. Trop. Med.

Parasit., 34:24; Johannsen, 1943, Ann. Ent. Soc. Amer., 36:773;

Lane, 1946, Rev. Ent. Rio. de J., 17:203; Mayer, 1952, Beitr.

Ent., 2:583; Lane, 1956, Rev. Bras. Biol., 16:299; Wirth, 1959,

Dtsch. Ent. Z. (N.F.), 6:236; Mayer, 1959, Dtsch. Ent. Z. (N.F.),

6:232; Lane, 1961, Stud. Ent. (N.S.), 4:453. (Type-species:

Paryphoconus angustipennis Enderlein, orig. desig.).

DIAGNOSIS. Body slender, dorsoventrally flattened. Eyes bare, widely separated. Female antennae much elongated, segments 11-15 with dense setose hairs; male antennae with few plumes, segments 12-14 with setose hairs. Palpi five-segmented, third segment simple.

Thorax narrowed in front, more or less conical. Legs long and slender; femora unarmed; femora and tibial vestiture with very fine erect hairs; last three tarsal segments relatively short; fourth segment cordate to subcylindrical; female claws equal, each with a small internal basal barb. Wing long and narrow, often with color pattern; r-m crossvein distinct but short; costa long extended almost to wing tip; one radial cell; posterior branch of radius closely approaching costa; median fork broadly sessile. Female abdomen slender with pairs of eversible glands and gland rods. Male genitalia: ninth sternite short, ninth tergite tapering with well developed lateral lobes; basistyles slender, dististyles elongated; aedeagus with slender arch and pointed tip; parameres separated.

Approximately 24 species have been described.

Distribution: South America.

This genus resembles Stenoxenus, Bezzia and Calyptopogon with the following exceptions: thorax not conical in front; parameres separated and antennae with setose hairs, these three characters are different from Bezzia and Calyptopogon. The lack of elbow of wing vein M_2 and the male genitalia separated separates this genus from Stenoxenus. Illustration: Fig. 76 Paryphoconus angustipennis Enderlein

Genus Pachyhelea Wirth

Pachyhelea Wirth, 1959, Bull. Brooklyn Ent. Soc. (N.S.), 54:50.

(Type-species: Ceratopogon magnus Coquillett, mon.)

DIAGNOSIS. Body stout and nearly bare. Eyes bare, well separated. Palpus small, all segments simple. Antennal segments 3-10 oval, segments 11-15 cylindrical and elongated. Scutum very robust large,

with an anterior spine; humeral pits conspicuous. Abdomen stout, cone-shaped. Legs large, hind coxa greatly enlarged; hind femur much enlarged and curved; hind tibia rather thick; no spines on femora and tibia. First tarsal segments of hind legs very long, fourth segment slightly cordiform, fifth segment slender with three pairs of ventral spines on distal half. Claws equal, small on the first fore legs, longer on hind legs; each with small mesal tooth. Wing broad without macrotrichia, microtrichia distinct; costa long; two radial cells; media widely sessile. Male genitalia: ninth sternite small, rounded; ninth tergite tapering with well developed lateral lobes; basistyle large; dististyle short with hook tip; aedeagus triangular shape, truncate end; parameres separated.

Only one species known.

Distribution: Mexico, Canal Zone, and Brazil.

Wirth (1959b) proposed this genus and selected Ceratopogon magnus Coq. as the type, as it is not related to any other genera of Ceratopogonidae.

Pachyhelea resembles Palpomyia in general, but differs in having unarmed femora and very short radial crossvein. Hind femora swollen as in Serromyia but unarmed and of different structure, closer to Sphaeromyias. The latter genus is distinctly separated from Pachyhelea in having typical ventral blunt spines (batonnets) on the fifth tarsomere.

Illustration: Fig. 77 Pachyhelea pachymera (Will.)

Genus Palpomyia Meigen

Palpomyia (Megerle, M. S., in) Meigen, 1818, Syst. Besch. Eur.

Zweif. Ins., 1:65; Stephens, 1829, Cat. Brit. Ins., 2:238;
 Johannsen, 1905, Bull. N. Y. State Mus., 86:105; Kieffer, 1906,
 Gen. Insectorum, fasc. 42:61, 1913, Rec. Ind. Mus., 9:187;
 Malloch, 1914, Bull. Ill. State Lab. Nat. Hist., 10:216; 1915,
 Bull. Ill. State Lab. Nat. Hist., 10:319; Kieffer, 1917, Ann.
 Mus. Nat. Hung., 15:295-318; Goetghebuer, 1920, Mem. Mus. Roy.
 Hist. Nat. Belg., 8:77; Edwards, 1926, Trans. Ent. Soc. London,
 74:416; Ingram and Macfie, 1931, Dipt. Pat. & S. Chile, pt. 2,
 fasc. 4, p. 215; Johannsen, 1931, Arch. f. Hydrobiol., Suppl.,
 9:437; Goetghebuer, 1932, Bull. Ann. Soc. Ent. Belg., :212;
 Macfie, 1939, Ruwenzori Exped., 1934-35, 1:93; 1939, Rev. Ent.,
 10:207; Tokunaga, 1939, Tenthredo, 2:295; 1940, Tenthredo, 3:157;
 Zilahi-Sebess, 1940, Folia Ent. Hungar., 5:85; Johannsen, 1943,
 Ann. Ent. Soc. Amer., 36:734; Lee, 1948, Proc. Linn. Soc. N.S.W.,
 73:57; Wirth, 1952, Univ. Calif. Pub. Ent., 9:217; Lane, 1960,
 Rev. Bras. Biol., 20:382. (Type-species: Ceratopogon flavipes
 Meigen, mon.).

Apogon Rondani, 1856, Dipt. Ital. Prod., 1:175. (Type-species:

Ceratopogon hortulanus Meigen, orig. desig.).

Alasion Rondani, 1857, Dipt. Ital. Prod., 2:14 (new name for Apogon
 Rondani, not Lacepede, 1802, Pisces).

Heteromyia Malloch (not Say), 1915, Bull. Ill. State Lab. Nat. Hist.,
 10:324; Kieffer, 1917, Ann. Mus. Nat. Hung., 15:324.

DIAGNOSIS. Moderate to large size, slender and almost bare body. Eyes bare and separated. Female antennal segments 3-10 oval with sparse verticils, segments 11-15 cylindrical and elongated; male antennae with few plumes; palpi slender, third segment simple. Mesonotum usually bearing a small tubercle or spine; surface clothed with fine hairs. Fore femora with stout ventral spines, the mid and hind ones usually without; fore femora often enlarged; the other legs usually slender; fourth tarsal segment bilobed beneath or cordiform fifth tarsal segment bare rarely with a few sharp ventral spines; claws equal, moderate size, sometimes with an inner basal tooth. Wings long and narrow, without macrotrichia; costa long; two radial cells, the second one well developed; intercalary fork absent; media widely sessile. Female abdomen with paired eversible glands opening between terga, these marked internally by slender sclerotized rodlike projections pointed to the base of abdomen. Male genitalia inverted; ninth tergite small, apicolateral processes large; basistyles and dististyles simple; aedeagus triangular to conical, apex caplike and clear; parameres fused or separated.

Approximately 241 species have been described.

Distribution: World-wide.

Thomsen (1937) described the larvae and pupae of Palpomyia tibialis and P. longipennis and pointed out the character which differentiated Palpomyia from the allied genera. Lee (1948) studied the larvae and pupae of the Palpomyia Group which included Palpomyia, Clinohoelea, Heteromyia, Xenohoelea, Johannsenomyia, and Dicrohoelea.

EGG. Palpomyia flavipes eggs are placed nearly vertical in the mass; nearly straight, long and narrow shape.

LARVA. Snake-like, without anterior or posterior prolegs. Largest size compared to other genera of Ceratopogonidae. Anal hairs usually shorter than last segment. Larvae can be separated from those of Bezzia and Probezzia by the flap-like structures attached to the conjunctiva on the inside of cast skin.

PUPA. Largest pupae of Ceratopogonidae. Operculum with one pair of setae. Respiratory trumpet with 10-23 spiracles.

Adult habits and larval habitats: larvae are aquatic, mostly occur in blanket algae or in the mucky or sandy margins or bottoms of lakes, ponds and streams. Some species breed in the profundal zone of deep lakes. The adults are predacious with strong, spinose legs.
(Wirth and Stone, 1956)

Abdomen with gland rods present resembles Stenoxenus, Bezzia, Phaenobezzia and Paryphocomus, but the presence of two radical cells on wing and simple wing veins separates Palpomyia from the above. The fore femora is always enlarged as in Heteromyia but the hind leg is not unusually long as in Heteromyia.

Subgenus Palpomyia s. str.

At least fore femur armed ventrally with black stout spines; claws moderately large.

Illustration: Fig. 78 Palpomyia plebeia (Loew)

Subgenus Diplohelea Kieffer, 1925

Subgenus type: Diplohelea parvula K.

All femora unarmed; claws very small.

Key for the Subgenera of Palpomyia

1. At least fore femur armed ventrally with black stout

spines (Fig. 78G) Palpomyia (Fig. 78)

All femora unarmed Diplochelea

Genus Bezzia Kieffer

- Bezzia Kieffer, 1899, Bull. Soc. Ent. France, p. 69; Johannsen, 1905, Bull. N. Y. State Mus., 86:102; Kieffer, 1906, Gen. Insectorum, fasc. 42:57; Johannsen, 1908, Bull. N. Y. State Mus., 124:267; Kieffer, 1913, Rec. Ind. Mus., 9:192; Malloch, 1914, J. N. Y. Ent. Soc., 20:281; 1915, Bull. Ill. State Lab. Nat. Hist., 10:345; Kieffer, 1919, Ann. Mus. Nat. Hung., 17:112; Goetghebuer, 1920, Mem. Mus. Roy. Hist. Nat. Belg., 8:96; Ingram and Macfie, 1921, Ann. Trop. Med. & Parasit., 15:361; Edwards, 1926, Trans. Ent. Soc. London, 74:422; Johannsen, 1931, Arch. f. Hydrobiol., 9:439; Macfie, 1932, Ann. Mus. Nat. Hist., ser. 10, 9:496; Sebess V. Zilah, 1938, Mat. Term. Ert., Budapest, 57:1092; Tokunaga, 1939, Tenthredo, 2:273; 1940, Tenthredo, 3:160; Zihali-Sebess, 1940, Folia Ent. Hungar., 5:98; de Meillon, 1942, Estac. anti-Malar. Lourenco Marques :19; Johannsen, 1943, Ann. Ent. Soc. Amer., 36:785; Lee, 1947, Proc. Linn. Soc. N.S.W., 72:339; Wirth, 1952, Univ. Calif. Pub. Ent., 9:226; Lane, 1958, Rev. Bras. Ent., 8:26; Tokunaga & Murachi, 1950, Ins. Micron., 12(3):417. (Type-species: Ceratopogon ornatus Meigen, orig. desig.).
- Probezzia Malloch (in part, not Kieffer), 1914, Proc. Biol. Soc. Wash., 27:137; 1915, Bull. Ill. State Lab. Nat. Hist., 10:352 (part); Macfie, 1940, Ann. Trop. Med. & Parasit., 34:29; Johannsen, 1943, Ann. Ent. Soc. Amer., 36:785, and authors.
- Pseudobezzia Malloch, 1915, Bull. Ill. State Lab. Nat. Hist., 10:351; Kieffer, 1919, Bull. Soc. Ent. France, p. 193; Johannsen, 1934, J. N.Y. Ent. Soc., 42:344; 1943, Ann. Ent. Soc. Amer., 36:762.

(Type-species: Ceratopogon expolitus Coquillett, orig. desig.).
Allobezzia Kieffer, 1917, Ann. Mus. Nat. Hung., 15:296 (Type-species:
Ceratopogon expolitus Coquillett, orig. desig.).
Lasiobezzia Kieffer, 1925, Ann. Soc. Ent. France, 94:54 (Type-species:
Bezzia pilipennis Lundstrom, orig. desig.).

DIAGNOSIS. Body slender to stout. Eyes bare, widely separated. Female antennal segments 3-10 short, oval, segments 11-15 cylindrical and elongated; male antennae plumose. Mesonotum with sparse bristles, without anterior spine or tubercle. Fore femora with stout ventral spines, sometimes also on mid and hind pairs; fore femora often somewhat swollen; fourth tarsal segment cordate, fifth segment cylindrical; claws simple and equal, basal internal tooth sometimes present. Wing narrow, without macrotrichia; one radial cell; R_1 and R_5 widely separated; costa long not reaching wing tip; intercalary fork absent; media sessile (Bezzia) or short petiolate (Pseudobezzia). Female abdomen with a pair of eversible glands as in Palpomyia. Male genitalia inverted; ninth sternite large, ninth tergite small with well developed apicolateral processes; basistyle and dististyle short; aedeagus triangular to conical; parameres fused, appearing as one long lobe.

Approximately 234 species have been described.

Distribution: World-wide.

The immature stages of this genus are very similar to those of Palpomyia. No distinct characters have been found to separate these two genera. Some descriptions of immature stages of Bezzia are presented in Thomsen (1937) who also gave the descriptions of Bezzia varicolor and B. flavitarsis.

EGG. Eggs are usually straight, long and narrow arranged almost vertical in the mass. Eggs of Bezzia varicolor are black, about twelve times longer than wide, they are surrounded by jelly.

LARVA. Larvae are snake-like without anterior or posterior prolegs. Cast skin has no flap-like structure.

PUPA. Pupa has three setae on operculum. Respiratory trumpet is short and dark. Caudal spines are stout with sharp black tips. Glandular discs are absent.

Larval habitat: the habitat of Bezzia larvae has been reported in Thomsen (1937). Bezzia varicolor larvae are found in algae in ponds.

This genus resembles Palpomyia but differs in lacking an anterior tubercle; femoral spines present or absent; fourth tarsomere short and cordate; vein R_{2+3} absent, only one radial cell on wing; median fork narrowly sessile.

Subgenus Bezzia s. str.

Median fork sessile; femora armed at least on fore legs; costa short; r-m crossvein ends slightly beyond forking point of M_1 and M_2 .

Illustration: Fig. 79 Bezzia (Bezzia) setulosa (Loew)

Subgenus Pseudobezzia Malloch, 1915

Subgenus type: Ceratopogon expolitus Malloch, 1915 (orig. desig.)

Median fork barely petiolate or very short petiole in male; costa short; legs very spiny; male genitalia large with extreme contraposition of the aedeagus and parameres.

Illustration: Fig. 80 Bezzia (Pseudobezzia) flavitarsis (Mall.)

Key for the Subgenera of Bezzia

1. Medial fork just petiolate (Fig. 80E) or with very short
petiole in male wing; legs very spiny (Fig. 80F);
..... Pseudobezzia (Fig. 80)
- Medial fork sessile (Fig. 79E); legs armed at least on
fore legs (Fig. 79H) Bezzia (Fig. 79)

Genus Phaenobezzia

Phaenobezzia Haeselbarth, 1965, S. Afr. Inst. Med. Res., Johannesburg, 51:297. (Type-species: Probezzia pistiae Ingram and Macfie, orig. desig.).

DIAGNOSIS. Body slender with fine hairs. Eyes bare and separated. Palpi slender; mandible with seven large teeth. Female antennal segments 3-10 oval, segments 11-15 elongated; male antennae with few plumes. Legs pale; hind femora rather stout; femora and tibiae unarmed; fourth tarsal segment simple; fifth segment with numerous, sharp, ventral batonnets; no batonnets on male tarsomere; female claws equal and small with internal barb; male claws simple, tip bifid. Wing with one radial cell, costa long. Abdomen hairy, elongated seventh abdominal segment bearing a pair of gland rods; spermathecae two. Male genitalia: ninth sternite large, ninth tergite tapering with well developed lateral lobes; basistyles and dististyles much reduced but distinctly separated; aedeagus slender with clear tip; parameres fused into one long lobe.

Approximately 12 species have been described.

Distribution: Africa, Sahara, and North America.

The immature stages were studied by Ingram and Macfie (1921) and Haeselbarth (1965).

EGG. Elongated with one end rather pointed.

LARVA. Pale or nearly white colored. Antenna and palpi small. Mental plate with a strong, pointed central tooth, and two more delicate teeth on each side. Hypopharynx bearing about 12 pointed teeth. Mandible large. Anal segment with 14 strong hairs distally.

PUPA. Respiratory trumpets usually bent posteriorly, rather short and broad, distal end infuscated. Spiracles about 18. Abdomen with spiculated integument and pigmented areas. Anal segment with acutely pointed, dark-tipped processes.

Several pupal specimens were collected in stagnant or flowing water, often among vegetation.

In 1965, Haeselbarth proposed a new genus Phaenobezzia to enclose species formerly placed in the genera Bezzia, Palporvya and Nilobezzia. It is well defined by the hypopygium of the male.

This genus is related to Bezzia, Probezzia and Nilobezzia. It has the following similar characters of Bezzia: gland rods present on abdomen; wing with one radial cell, and male parameres fused in one long lobe. It differs in having unarmed femora and reduced claspers of male genitalia. Male genitalia with basistyles and dististyles distinctly separated, not fused to form a thumblike process which separates it from Nilobezzia.

Batonnets present only on fifth tarsomere of female similar to Probezzia, but without ventral hair tufts in Phaenobezzia and the character of male genitalia separates these two genera.

Illustration: Fig. 81 Phaenobezzia pistiae (I. & M.)

Genus A

This genus is closely related ^{to} Sphaeromias by the following characters: fifth tarsal segments armed with numerous batonnets; anterior tubercle present; all claws equal, each with inner barb; wing with two radial cells; legs with bristles on femora and tibiae; fifth tarsomeres of male with few batonnets.

It differs from Sphaeromias by the following characters:
 claw with inner tooth very large, subequal to the claw; legs with
 spines only on fore femora; eighth abdominal segment without ventral
 hair tufts; fore femora swollen, fore tibiae arched as in Heteromyia;
 spermatheca one, eyes separated distinctly; anterior strong erect
 spine well developed; male genitalia with parameres separated.

Four species:

species 1. Thailand Fig. 82

species 2. Ceylon

species 3. Viet Nam

species 4. Sumatra (? Palpomyia caesia Macfie 1934)

Genus B

This genus resembles Pachyelea by the following characteristics:
 scutum with a median anterior spine; female abdomen with gland rods
 on seventh segment; hind femur enlarged and curved; hind tibia with
 rough margin; first tarsal segment of hind legs very long; fifth
 tarsomere with ventral spines; claws small and equal on first four
 legs, longer on hind legs, each claw with mesal tooth; spermathecae
 two; eyes widely separated.

The following characters differentiate this genus from Pachyelea:
 all femora with ventral spines; mid tibia with an apical spine; wing
 with one radial cell; ventral spines on fifth tarsal segments approxi-
 mately four pairs, scattered along the entire segment, while in
Pachyelea they appear only on distal half; abdomen slender and elon-
 gated, female abdomen with sclerotized plate; male genitalia large

with spinelike lobe on basistyle.

One species:

Rio Raposo, Colombia Fig. 83

Genus C

This genus has the following characters of Palpomyia: mesonotum with small tubercle; femora armed with ventral spines; two radial cells present on wing, eyes separated; spermathecae two.

It also resembles Homohoelea by having mandible with apical teeth large; all femora armed with ventral spines; mid tibia with an apical ventral spine.

It can be differentiated from Homohoelea particularly in having hind femora swollen and fifth tarsomere without batonnets. The following additional characters separate it from Palpomyia and Homohoelea: claws of hind legs longer than those of the first four legs; fore femora slender not enlarged; hind first tarsomere very long; fourth tarsomere elongated, simple; fifth tarsomere of mid leg short; mandible spiny; no gland rods on abdomen.

One species, female only:

Chiapas, Mexico Fig. 84

Genus D

This genus is closely related to Pachyhelea by the following characters: eyes well separated; anterior tubercle present on mesonotum; abdomen cone-shaped with gland rods; hind femora enlarged and curved, hind tibiae with toothed apex; femora and tibiae unarmed; fifth tarsomeres sometimes with spines; spermathecae two; wing with

two radial cells; fifth tarsomere of hind leg long.

The following characters differentiate the genus from Pachyhelea: hind tarsal claws longest; spines (if present) on fifth tarsomere about two to four pairs; gland rods appear on abdominal segments five, six and seven; wing with costa prolonged beyond R_5 nearly to wing tip.

Two species:

species 1. Tex., Panama, Colombia; legs and wing dark; Fig. 85.

species 2. Panama, Colombia; legs pale bands, wing whitish;

Fig. 86.

Genus E

This genus has the following characteristics of Mallochohelea: all claws equal; wing with two radial cells; mandible teeth large; antennae elongated; eyes broadly separated; hind femur enlarged; batonnets present on fifth tarsomere.

It resembles Pachyhelea but differs from Mallochohelea by the following points: anterior spine present; hind legs enlarged, femora unarmed; two pairs of batonnets on fifth tarsomere; claws equal, each with inner basal tooth; no ventral hair tufts on eighth abdominal segment; abdomen with gland rods but widely separated from each other; wing with two radial cells.

The following characteristics differentiate this genus from Pachyhelea: abdomen not cone-shaped; hind femora not curved but swollen in the middle; tibia without toothed margin; first tarsomere of hind leg simple not long; ventral spines of fifth tarsomere not

located only on distal half of the segment; spermathecae one; mandible with few large teeth.

One species, female only:

Colombia, Fig. 87.

Genus F

This genus resembles Sphaeromias by the following characters:

legs usually with ventral spines or bristles on femora and dorsal side of tibiae; fifth tarsomere with batonnets; claws large with inner basal tooth; spermathecae two. No gland rods.

It differs from Sphaeromias by the following characters: eyes widely separated; fourth tarsomere cordate to oval; hind claws longest; wing with one or two radial cells; costa extends beyond R_5 nearly to wing tip; male genitalia: basistyles with additional processes, dististyle large; ninth tergite small, parameres separated.

Two species:

species 1. Panama, Colombia; one radial cell; Fig. 88.

species 2. Panama, Costa Rica; two radial cells; Fig. 89.

Genus G

This genus is characterized by the following characters:

anterior tubercle present; femora unarmed below; tibia with bristles; fourth tarsomere cordate; fifth tarsomere stout, no batonnets; claws equal, short, sharp with internal tooth; abdomen slender, with pattern on ventral side; one large spermatheca, pear-shaped; wing with two radial cells, costa short, r-m crossvein short, media sessile, microtrichia well developed; proboscis short with large mandible; palpi

with third segment swollen; eyes separated; antennal segments three to nine oval, 10-15 elongated.

One species:

Colombia, Fig. 90.

Genus H

This genus resembles Mallochohelea by the following points: eyes broadly separated; mandible with large teeth; female antennae long, fifth tarsomere bearing about five pairs of batonnets; claws long and equal, wing with two radial cells; spermathecae two.

It is differentiated from Mallochohelea by the following characters: anterior part of thorax somewhat cone-shaped; anterior tubercle poorly developed; legs long and slender, subequal size; tibiae with dorsal bristles, mid tibia with an apical spine; second tarsomere of mid leg distinctly shorter than that of the other legs, claws with internal basal tooth as in Sphaeromias; seventh abdominal segment with a pair of ventral sclerotized plates and hairy.

One species:

Colombia, Fig. 91.

Genus J

This genus is closely related to Sphaeromias by the following characters: eyes contiguous; fifth tarsomere bearing batonnets; claws large and equal; two spermathecae.

It differs from Sphaeromias by having short antennae with segments 3-10 oval; anterior tubercle absent; legs without spines on femora or tibiae; tibiae of second leg short; claws with internal tooth

in one and external tooth in the other; wing with one radial cell.

One species:

Brazil Amazonas, Rio Paru; Fig. 92.

Genus K

It resembles genus H by the following characters: female seventh abdominal segment with ventral, hairy, sclerotized plates; two spermathecae, legs with bristles on femora and tibiae second tarsomere of mid leg shorter than that of other legs; mid tibiae with distal spine; legs long and slender; fifth tarsomere with batonnets;; claws with internal tooth, anterior tubercle poorly developed; eyes broadly separated, mandible with large teeth, antennae long.

It is differentiated from genus H by having one radial cell on wing.

This genus is also related to Bezzia by having equal claws; wing with one radial cell; leg sometimes with spine on femur and tibia.

One species:

Colombia, Fig. 93.

Genus L

This genus is similar to genus E in the following points: claws equal, mandible with few large teeth; antennae long; eyes broadly separated; femora unarmed; hind femur enlarged; fifth tarsomere with few batonnets; abdomen with gland rods and widely separated; one spermatheca.

It resembles Bezzia by having one radial cell on the wing; fore femora rather swollen, fourth tarsomere cordate, claws equal, abdomen with a pair of eversible glands.

The genus is differentiated from genus E and Bezzia by having tarsal segments two to five distinctly short.

One species:

Colombia, Fig. 94.

Genus M

This genus resembles Parabezzia by the following characters: female antennal segments 3-10 oval, segments 11-15 cylindrical to elongated; male antenna plumose; tarsi with ventral spines; fifth tarsomere swollen, claws long, unequal in female, small and equal in male; wing with media petiolate; male genitalia, aedeagus arched, parameres reduced to form triangular sclerite behind aedeagus. The character of unequal claws on hind legs resembles Alluaudomyia.

It differs from Parabezzia and Alluaudomyia by having palpi four segmented; coxae of male with few bristles; fourth tarsomere cordiform to oval; costa short, wing with radial cells obliterated; one large spermatheca; male genitalia with narrow ninth tergite, basistyles large, dististyles slender with claw-like tips; claws with both external and internal barbs; eyes narrowly separated. The following points are particularly different from Alluaudomyia: third palpal segment swollen with deep sensory pit; antennal segments 3-10 oval, 11-15 cylindrical to elongated; wing with microtrichia present.

One species:

Brazil, Fig. 95.

Genus N

This genus is similar to Brachypogon in the absence of the lower branch of media on wing; legs slender and unarmed. It also resembles Austroconops in the following characters: hind tibia with plumose spur; four tibial comb; claws small and equal.

It differs from Brachypogon and Austroconops by the following points: eyes bare; antennae with segments 3-10 oval, 11-15 long; one spermatheca; palpi three-segmented; mandible with five teeth; one triangular radial cell. It particularly differs from Brachypogon in having small, equal claws and from Austroconops by the absence of the lower branch of media.

One species, female only:

Colombia, Fig. 96.

Genus O

It resembles Parabazzia by the following points: wing with costa extended beyond R_5 and media petiolate.

The genus is differentiated from Parabazzia by having pubescent eyes; claw single with barb; wing with two radial cells and palpi three-segmented.

One species:

Colombia, Fig. 97.

Genus P

This genus is related to Camptopterochelea by the following characteristics: eyes widely separated; proboscis short; thorax

dark; legs rather stout, hind tibia with more hairs on comb; wing broad, two radial cells, radial vein thickened, cubital stem and 1A distinct.

It differs from Camptopterohelea by having pubescent eyes; antenna 14-segmented, all segments similar in shape; palpi four-segmented; third segment robust; proboscis short but large; mandible teeth very small and blunt; two claws present; wing with first radial cell not well developed, one median vein present, microtrichia simple; spermathecae two.

One species:

Florida, California; Fig. 98.

Genus Q

It is related to Camptopterohelea by the following points: eyes widely separated; palpi two-segmented; proboscis vestigial; thorax dark; legs rather stout; wing broad; one spermatheca.

It is differentiated from Camptopterohelea by having pubescent eyes; two claws, wing with radial cells absent, median fork present with petiolated media, microtrichia simple; antennal segments 3-10 round, 11-15 oval to cylindrical; male antennae with eight segments, without plume; male genitalia with ninth tergite large and truncated end, aedeagus arched, paramere absent.

One species:

Ecuador, Fig. 99.

Genus R

This genus resembles Parabezzia by the following characters:

eyes widely separated; palpi four-segmented, first and second segments indistinctly separated; antennal segments 3-10 oval, 11-15 cylindrical to elongated; male antennae with well developed plumes, tarsi with ventral spines, fourth tarsomere cordate, fifth segment swollen, claws long and equal; wing with one radial cell, costa prolonged beyond R_5 , media petiolate; spermathecae two.

It differs from Parabezzia by having pubescent eyes; first tarsomere of mid leg longest and with spines; coxae of male with few hairs; claws with inner barb, tibia of fore leg swollen centrally; wing broad; male genitalia with basistyles large, bearing basal spine-like processes, dististyles with hook-like tips, aedeagus arched, paramere absent.

One species:

Amazonas, Brazil; Fig. 100.

Genus S

The male of this genus is characterized as follows: eyes pubescent and widely separated; proboscis vestigial; palpi two-segmented; antennae with eight segments, segments three and four oval, segments five to eight elongated, without plumes; legs slender; tarsal segments two to five similar in shape and sub-equal; fourth tarsal segment cylindrical; claws small and equal; wing without radial cells, posterior branch of media short, $M_3 + 4$ short; male genitalia with basistyles and dististyles small, ninth sternite small, ninth tergite large with truncated margin, aedeagus

arched with arms parallel, parameres absent.

One species, male only:

Ecuador, Fig. 101.

Genus T

This genus has the following characteristics of Mallochohelea: eyes widely separated; mandible teeth large; female antennae long; no anterior spine or tubercle; legs slender; fifth tarsomere with about six pairs of batonnets; claws long and equal with external basal tooth; male claws small, slightly cleft at tip; spermathecae two; ventral hair tufts on eighth abdominal segment present.

It differs from Mallochohelea by having one radial cell on wing; mandible with serrate margin; all femora curved and enlarged distally, spermathecae large; male genitalia with parameres fused basally, separated and fused again distally; abdomen slender.

One species:

Mallochohelea amnicola Macfie; Brazil, Colombia; Fig. 102.

The following four genera are not represented in our collections. Since specimens were not available for study and since the original descriptions were inadequate they were not included in the keys.

All available information is included here. These can be worked into the keys when specimens are available for study.

Genus Dolichohelen Edwards, 1929(Type-species: Dolichohelen polita Edwards, mon.)

Thorax produced anteriorly, mesonotum with an anterior tubercle; wing narrow, second radial cell very long extending to more than four-fifths of wing length, median fork with short stem, anal vein straight; proximal antennal segments of female more elongate, one to five times as long as broad.

Genus Acanthohelen Kieffer, 1917(Type-species: Acanthohelen pruinosa Kieffer, mon.)

Fourth tarsomeres bilobed on all legs, all femora and tibiae spinose; male antenna with last three segments elongated.

Genus Luciarmia de Meillon, 1937(Type-species: Luciarmia biloba de Meillon, mon.)

Wing densely hairy, wing venation greatly modified, vein M_2 absent, second radial cell greatly prolonged and broad distally. The costa, vein R_{4+5} , and vein M_1 meet in a point at the wing tip where there is a distinct indentation at the wing margin and the fringe is modified into lanceolate scales.

Genus Ceratobezzia Kieffer, 1917(Type-species: Ceratobezzia fallax K.)

Fourth tarsomeres bilobed each armed with two stout spines, fifth tarsomeres greatly swollen on fore legs; claws unequal on mid and hind legs but equal on fore legs; one spermatheca; one radial cell.

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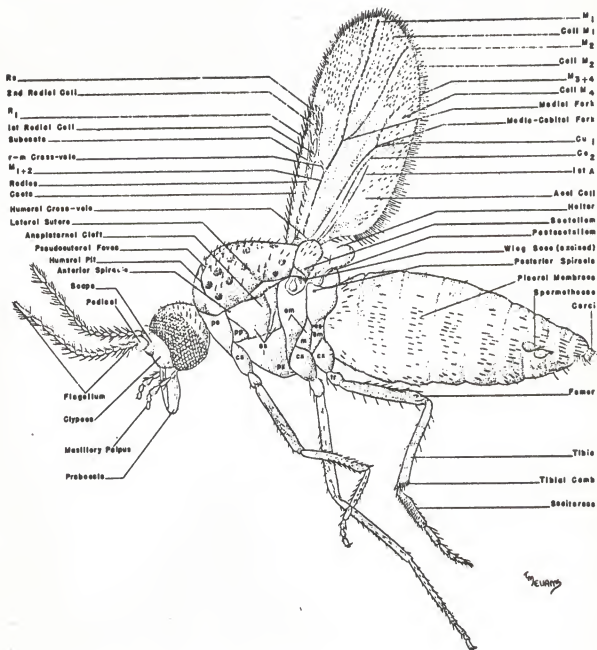


Figure 1.--Culicoides furens (Poey): lateral view of female, left wing and right leg removed, with parts labeled.

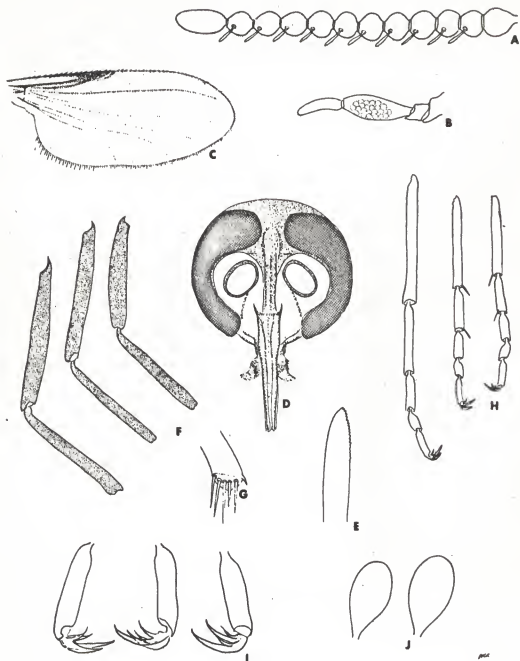


Figure 2.--Leptoconops (Leptoconops) stygius Skuse: A, female antenna; B, female palpus; C, female wing; D, female head; E, mandible; F, female legs; G, enlarged hind tibial comb; H, female tarsi; I, female fifth tarsomeres and claws; J, female spermathecae.

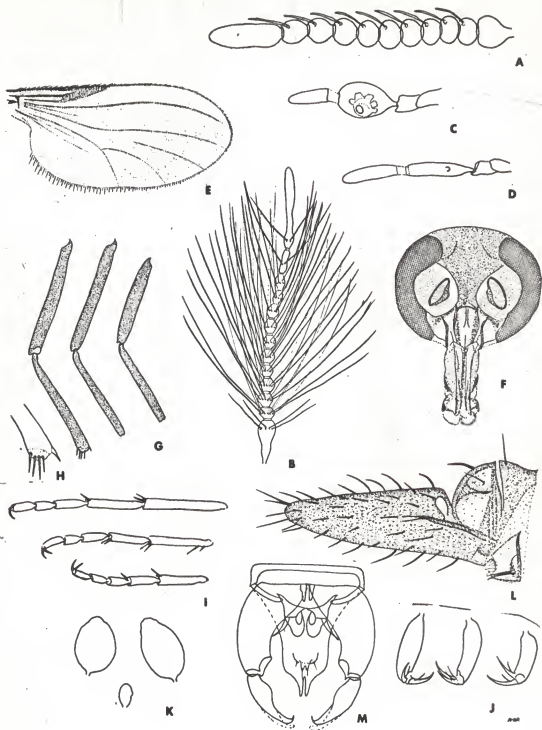


Figure 3.--*Leptoconops* (*Holoconops*) *kerteszi* K.: A, female antenna; B, male antenna; C, female palpus; D, male palpus; E, female wing; F, female head; G, female legs; H, enlarged hind tibial comb; I, female tarsi; J, female fifth tarsomeres and claws; K, female spermathecae; L, female lamella; M, male genitalia.

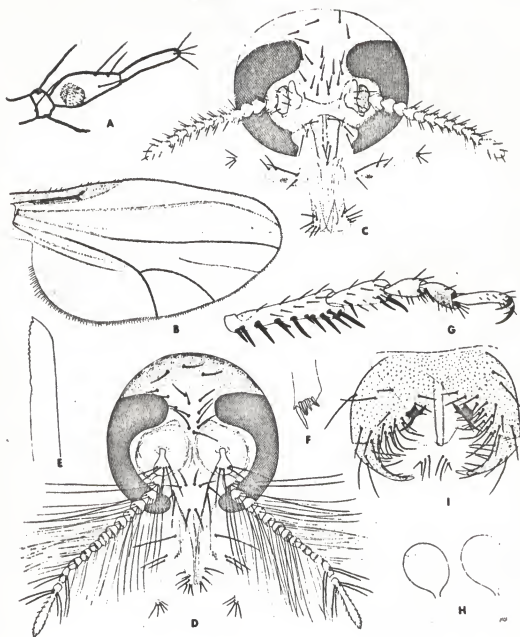


Figure 4.--Leptoconops (Styloconops) albiventris (Meijere):
 A, female palpus; B, female wing; C, female head; D, male head;
 E, mandible; F, enlarged hind tibial comb; G, female front tarsus;
 H, female spermathecae; I, male genitalia.

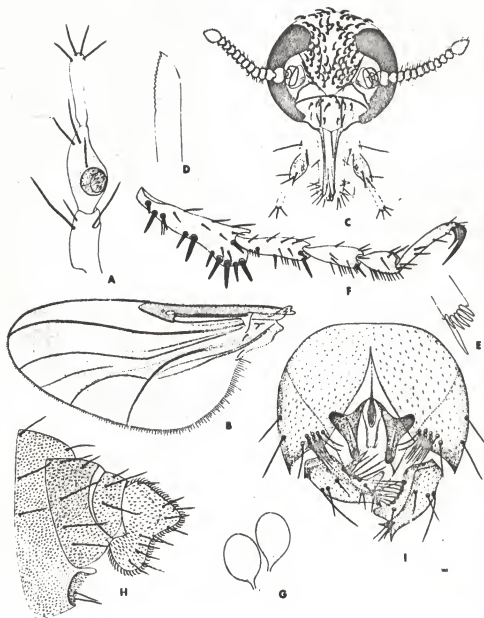


Figure 5.--Leptoconops (Styloconops) spinosifrons Carter:
 A, female palpus; B, female wing; C, female head; D, mandible;
 E, enlarged hind tibial comb; F, female front tarsus; G, female
 spermathecae; H, female lamella; I, male genitalia.

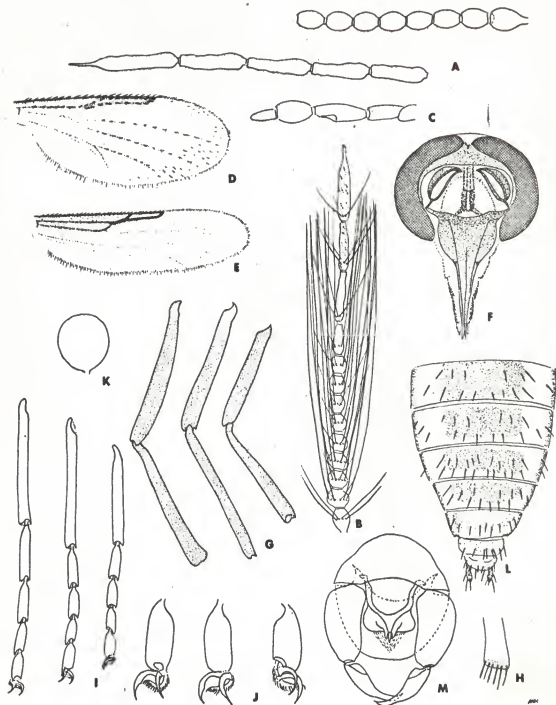


Figure 6.--Atrichopogon (Atrichopogon) levis (Coq): A, female antenna; B, male antenna; C, female palpus; D, female wing; E, male wing; F, female head; G, female legs; H, enlarged hind tibial comb; I, female tarsi; J, female fifth tarsomeres and claws; K, female spermatheca; L, female abdomen; M, male genitalia.

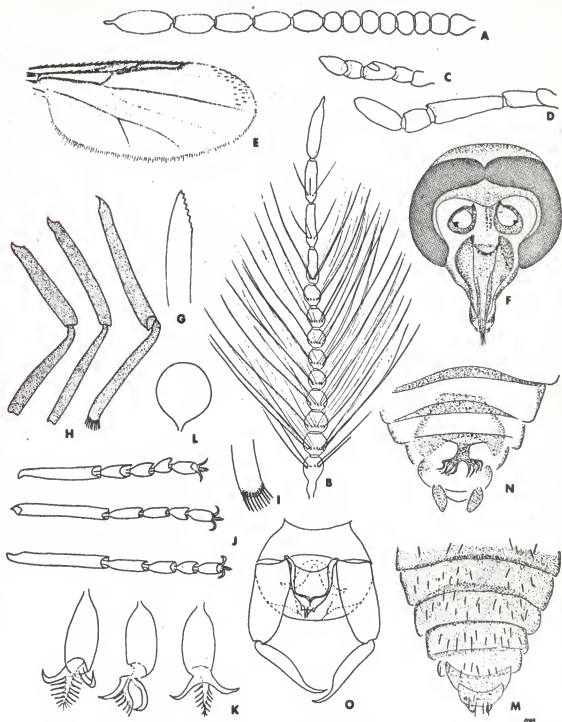


Figure 7.--Atrichopogon (Psilokempia) arcticus (Coq.): A, female antenna; B, male antenna; C, female palpus; D, male palpus; E, female wing; F, female head; G, mandible; H, female legs; I, enlarged hind tibial comb; J, female tarsi; K, female fifth tarsomeres and claws; L, female spermatheca; M, dorsal view of female abdomen; N, ventral view of female abdomen; O, male genitalia.

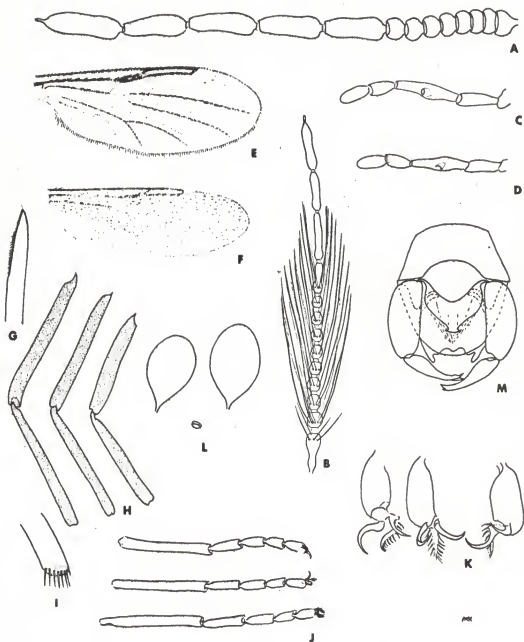


Figure 8.--Atrichopogon (Melochelela) meloesugans K.: A, female antenna; B, male antenna; C, female palpus; D, male palpus; E, female wing; F, male wing; G, mandible; H, female legs; I, enlarged hind tibial comb; J, female tarsi; K, female fifth tarsomeres and claws; L, female spermathecae; M, male genitalia.

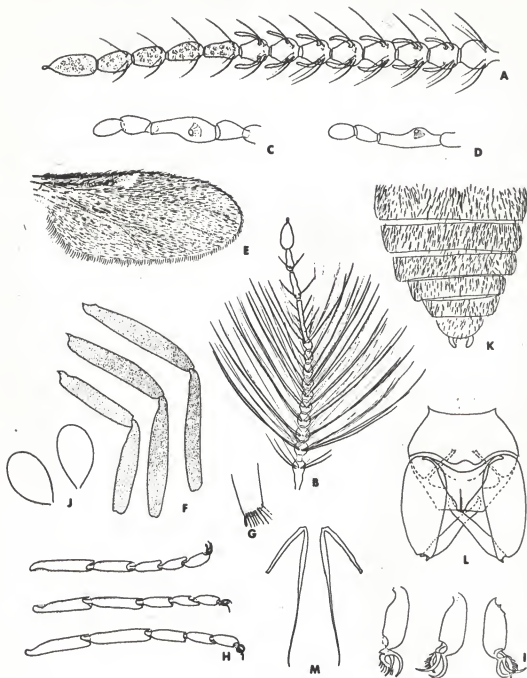


Figure 9.--*Forcipomyia* (*Forcipomyia*) *bipunctata* (L.): A, female antenna; B, male antenna; C, female palpus; D, male palpus; E, female wing; F, female legs; G, enlarged hind tibial comb; H, female tarsi; I, female fifth tarsomeres and claws; J, female spermathecae; K, female abdomen; L, male genitalia; M, male parameres.

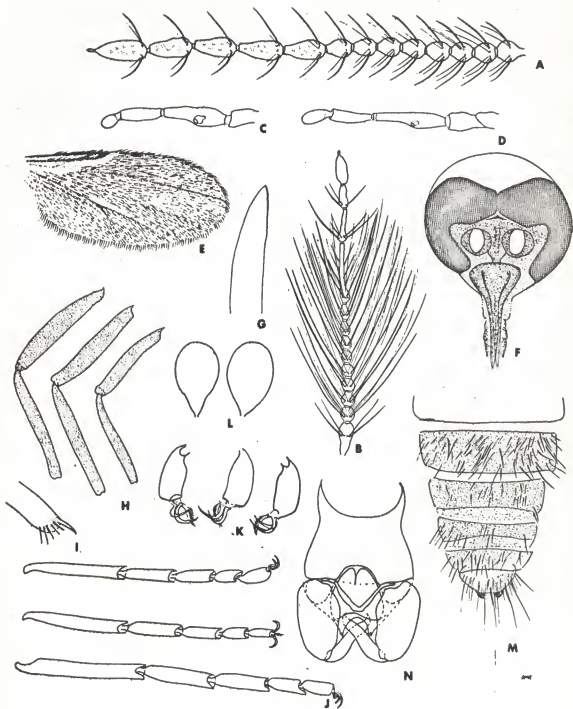


Figure 10.--Forcipomyia (Proforcipomyia) wirthi Saunders:
 A, female antenna; B, male antenna; C, female palpus; D, male palpus;
 E, female wing; F, female head; G, mandible; H, female legs; I,
 enlarged hind tibial comb; J, female tarsi; K, female fifth tarsomeres
 and claws; L, female spermathecae; M, female abdomen; N, male genitalia.

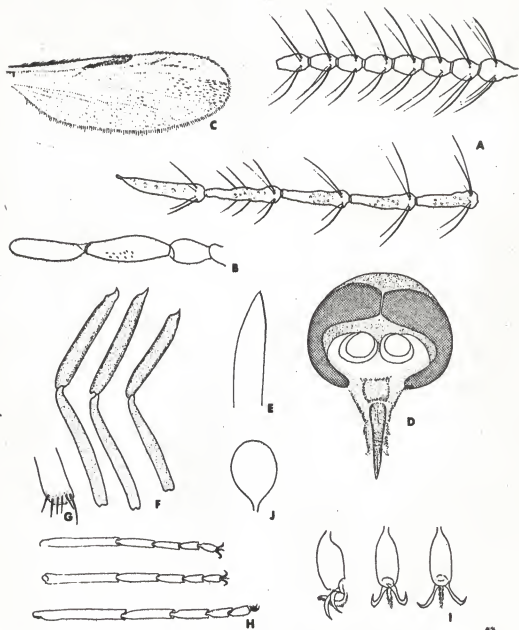


Figure 11.--*Forcipomyia* (*Warmkea*) *aerea* Saunders: A, female antenna; B, female palpus; C, female wing; D, female head; E, mandible; F, female legs; G, enlarged hind tibial comb; H, female tarsi; I, female fifth tarsomeres and claws; J, female spermatheca.

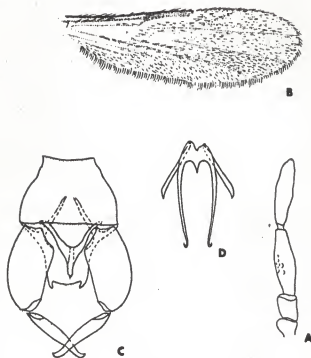


Figure 12.--*Forcipomyia* (*Warmkea*) *tuberculata* Saunders: A, male palpus; B, male wing; C, male genitalia; D, male parameres.

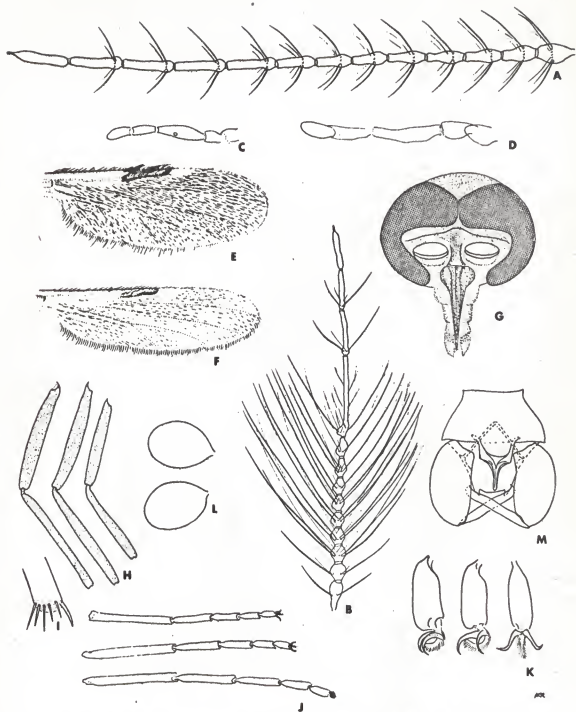


Figure 13.--Forcipomyia (Caloformipomyia) glauca Edwards:
 A, female antenna; B, male antenna; C, female palpus; D, male palpus;
 E, female wing; F, male wing; G, female head; H, female legs; I,
 enlarged hind tibial comb; J, female tarsi; K, female fifth tarso-
 meres and claws; L, female spermathecae; M, male genitalia.

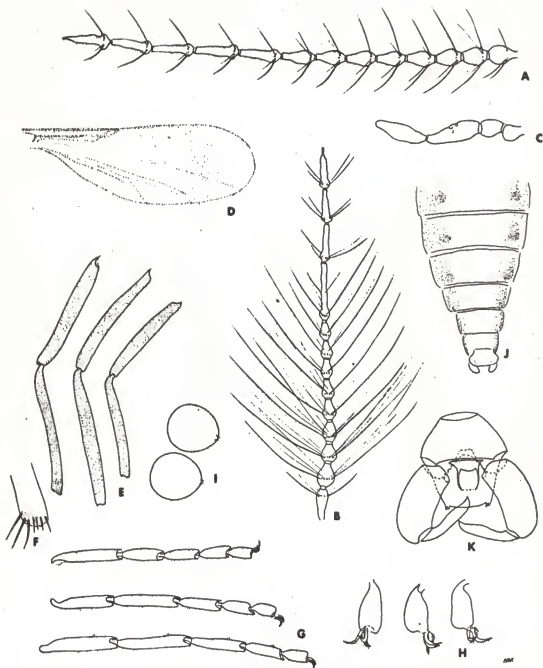


Figure 14.--Forcipomyia (Metaforcipomyia) pluviialis Malloch:
 A, female antenna; B, male antenna; C, female palpus; D, female wing;
 E, female legs; F, enlarged hind tibial comb; G, female tarsi; H,
 female fifth tarsomeres and claws; I, female spermathecae; J, female
 abdomen; K, male genitalia.

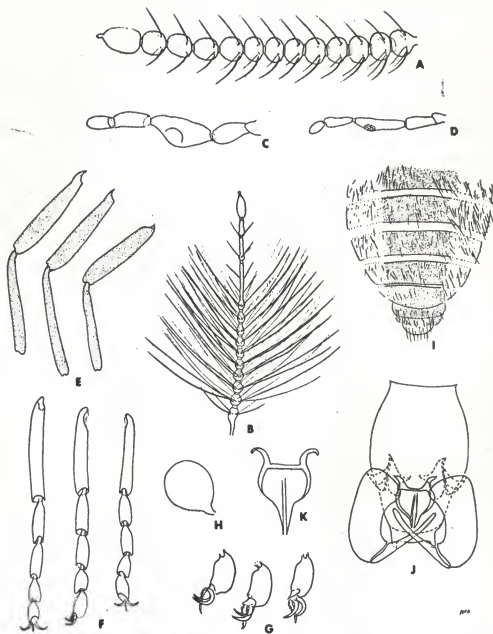


Figure 15.--Forcipomyia (Thyridomyia) palustris Saunders:
 A, female antenna; B, male antenna; C, female palpus; D, male palpus;
 E, female legs; F, female tarsi; G, female fifth tarsomeres and claws;
 H, female spermatheca; I, female abdomen; J, male genitalia; K, male
 parameres.

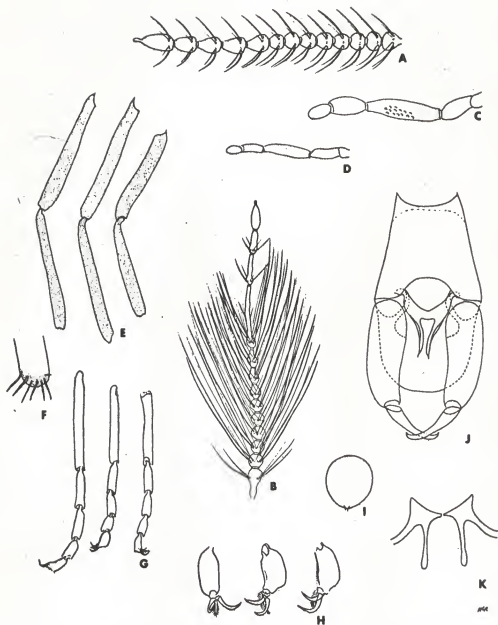


Figure 16.--*Forcipomyia* (*Synthyridomyia*) *colemani* Wirth:
 A, female antenna; B, male antenna; C, female palpus; D, male palpus;
 E, female legs; F, enlarged hind tibial comb; G, female tarsi; H,
 female fifth tarsomeres and claws; I, female spermatheca; J, male
 genitalia; K, male parameres.

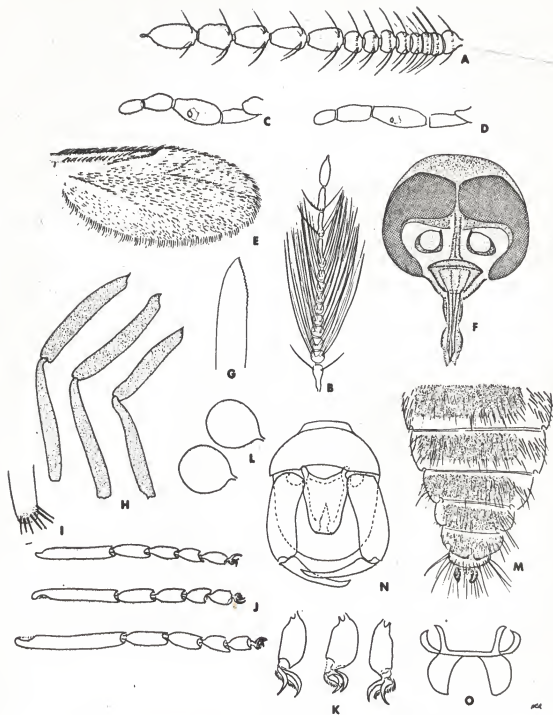


Figure 17.--Forcipomyia (Trichohoelea) fijiensis (Macfie):
 A, female antenna; B, male antenna; C, female palpus; D, male palpus;
 E, female wing; F, female head; G, mandible; H, female legs; I, enlarged
 hind tibial comb; J, female tarsi; K, female fifth tarsomere and claws;
 L, female spermathecae; M, female abdomen; N, male genitalia; O, male
 parameres.

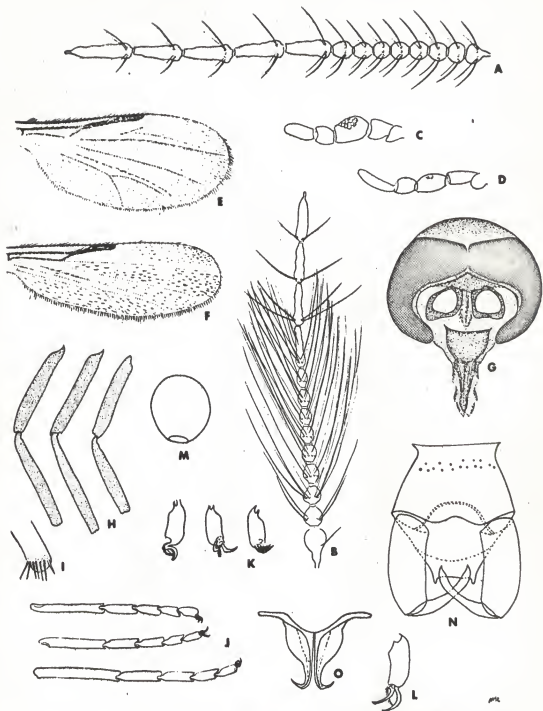


Figure 18.--Forcipomyia (Lasiohelea) fairfaxensis Wirth: A, female antenna; B, male antenna; C, female palpus; D, male palpus; E, female wing; F, male wing; G, female head; H, female legs; I, enlarged hind tibial comb; J, female tarsi; K, female fifth tarsomeres and claws; L, male fifth tarsomere and claws; M, female spermatheca; N, male genitalia; O, male parameres.

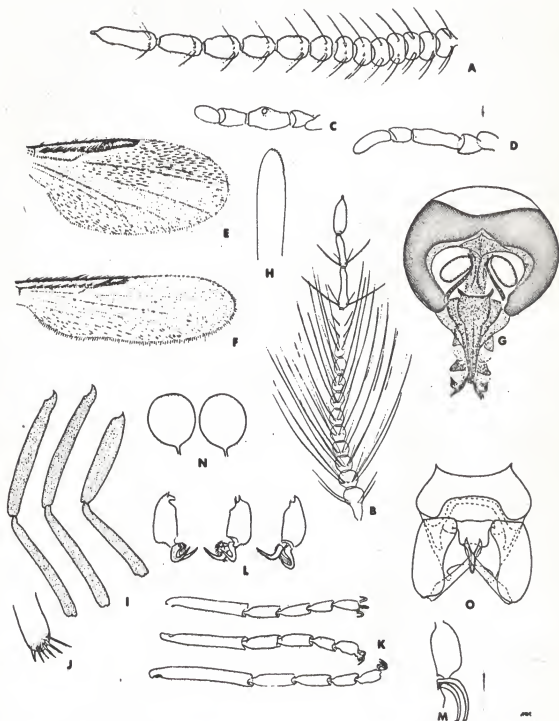


Figure 19.-- *Forcipomyia* (*Neoforcipomyia*) *eques* (Joh.):
 A, female antenna; B, male antenna; C, female palpus; D, male palpus;
 E, female wing; F, male wing; G, female head; H, mandible; I, female
 legs; J, enlarged hind tibial comb; K, female tarsi; L, female fifth
 tarsomeres and claws; M, male fifth tarsomere and claws; N, female
 spermathecae; O, male genitalia.

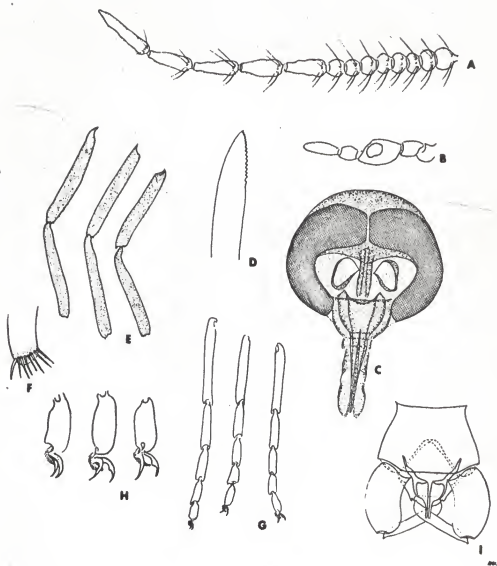


Figure 20.--Forcipomyia (Dacnoforcipomyia) anabaenae Chan & Saunders: A, female antenna; B, female palpus; C, female head; D, mandible; E, female legs; F, enlarged hind tibial comb; G, female tarsi; H, female fifth tarsomeres and claws; I, male genitalia.

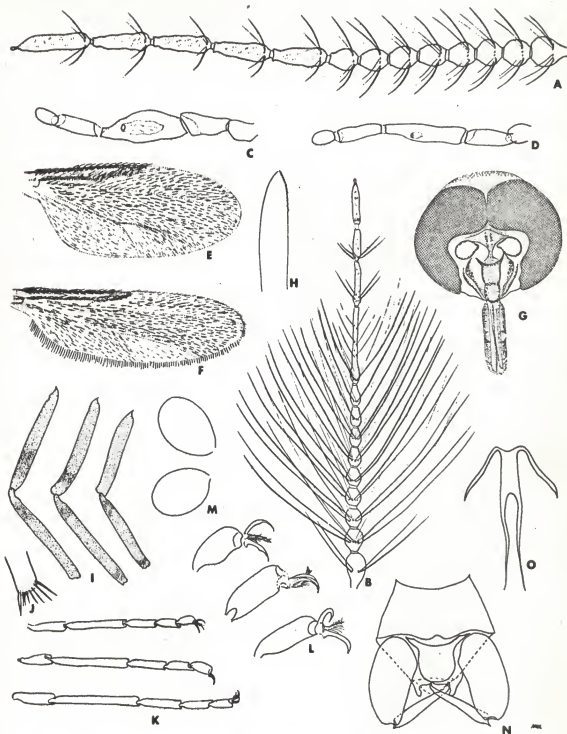


Figure 21.--*Forcipomyia* (*Phasmidohelea*) *fuliginosa* (Mg.):

A, female antenna; B, male antenna; C, female palpus; D, male palpus; E, female wing; F, male wing; G, female head; H, mandible; I, female legs; J, enlarged hind tibial comb; K, female tarsi; L, female fifth tarsomeres and claws; M, female spermathecae; N, male genitalia; O, male parameres.

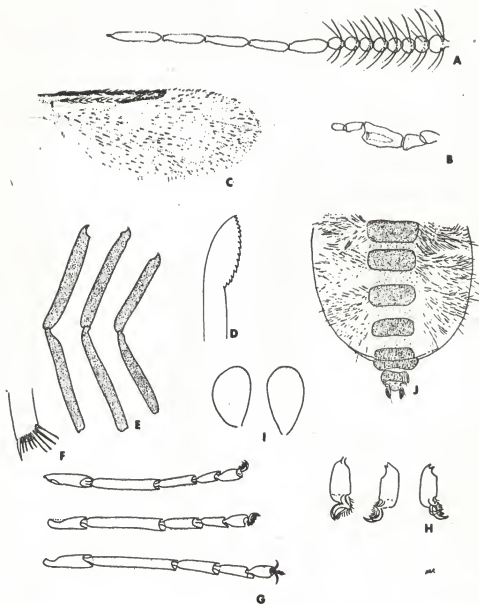


Figure 22.--Forcipomyia (Phasmidohelea) sp.: A, female antenna; B, female palpus; C, female wing, D, mandible; E, female legs; F, enlarged hind tibial comb; G, female tarsi; H, female fifth tarsomeres and claws; I, female spermathecae; J, female abdomen.

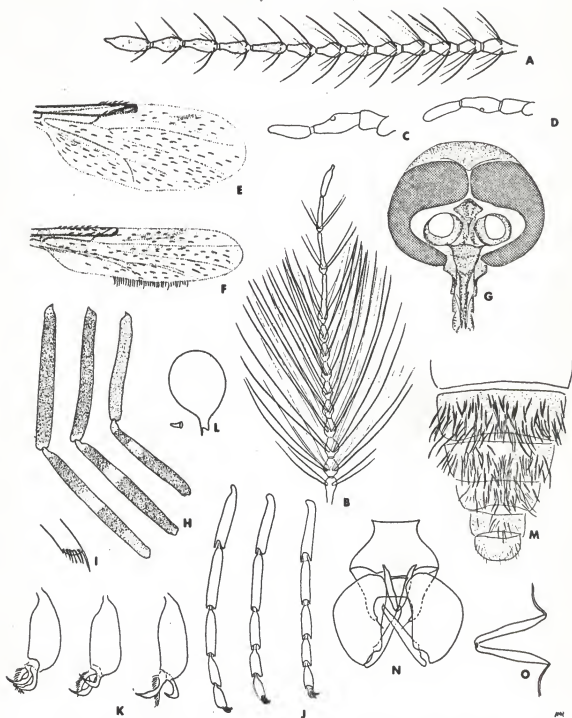


Figure 23.--*Forcipomyia* (*Lepidochelea*) *annulatipes* Macfie: A, female antenna; B, male antenna; C, female palpus; D, male palpus; E, female wing; F, male wing; G, female head; H, female legs; I, enlarged hind tibial comb; J, female tarsi; K, female fifth tarsomere and claws; L, female spermatheca; M, female abdomen; N, male genitalia; O, male parameres.

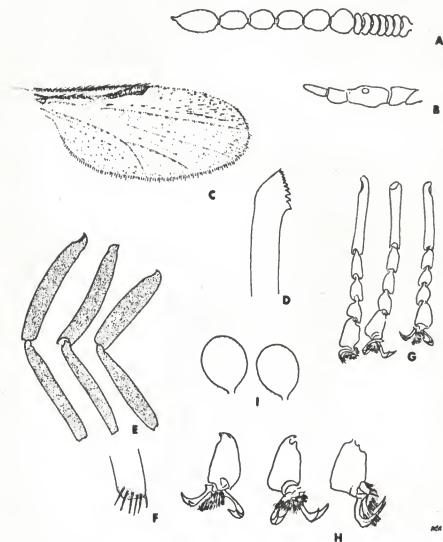


Figure 24.--Forcipomyia (Pterobosca) fusicornis (Coq.): A, female antenna; B, female palpus; C, female wing; D, mandible; E, female legs; F, enlarged hind tibial comb; G, female tarsi; H, female fifth tarsomeres and claws; I, female spermathecae.

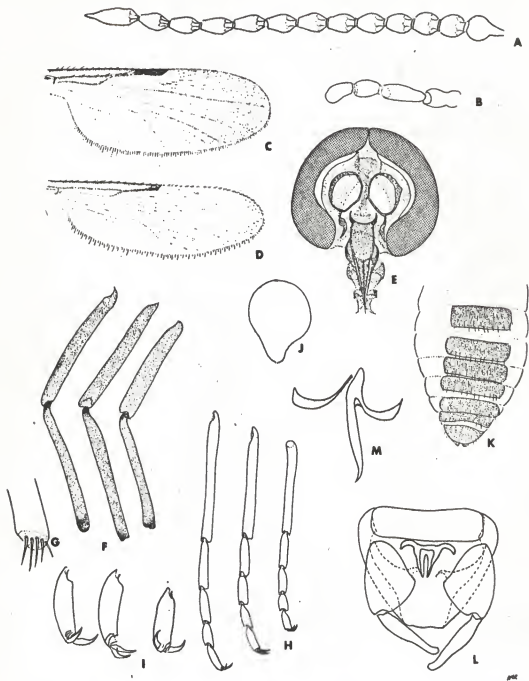


Figure 25.--*Dasyhelea* (*Dasyhelea*) *grisea* (Coq.): A, female antenna; B, female palpus; C, female wing; D, male wing; E, female head; F, female legs; G, enlarged hind tibial comb; H, female tarsi; I, female fifth tarsomeres and claws; J, female spermatheca; K, female abdomen; L, male genitalia; M, male paramere.

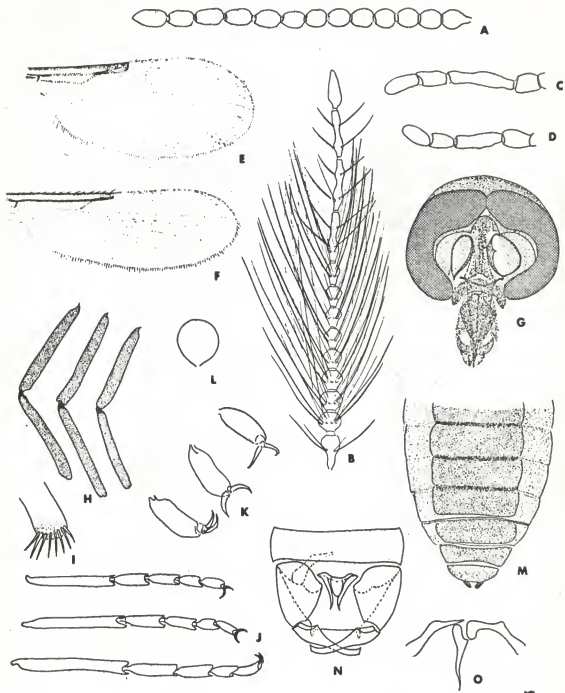


Figure 26.--Dasyhelea (Pseudoculicoides) mutabilis (Coq.);
 A, female antenna; B, male antenna; C, female palpus; D, male palpus;
 E, female wing; F, male wing; G, female head; H, female legs; I,
 enlarged hind tibial comb; J, female tarsi; K, female fifth tarsomeres
 and claws; L, female spermatheca; M, female abdomen; N, male genitalia;
 O, male paramere.



Figure 27.--*Dasyhelea* (*Prokempia*) *cincta* (Coq.): A, female antenna; B, male antenna; C, female palpus; D, female wing; E, female head; F, female legs; G, enlarged hind tibial comb; H, female tarsi; I, female fifth tarsomeres and claws; J, female spermathecae; K, female abdomen; L, male genitalia.

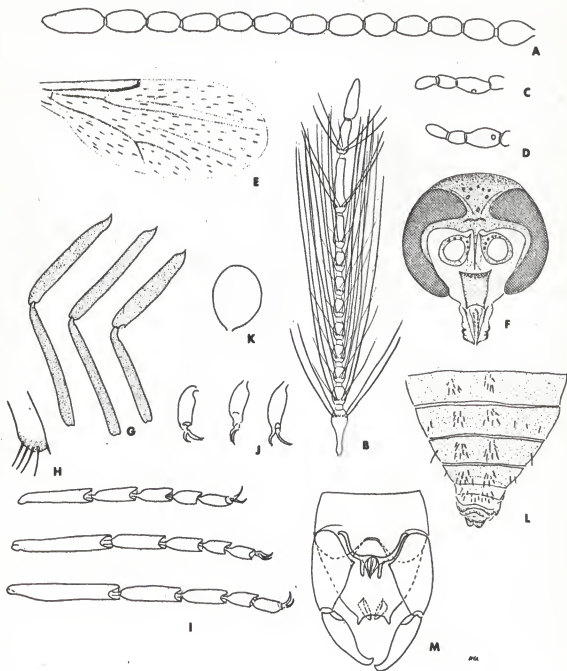


Figure 28.--*Paradasyhelea minuta* Wirth & Lee: A, female antenna; B, male antenna; C, female palp; D, male palp; E, female wing; F, female head; G, female legs; H, enlarged hind tibial comb; I, female tarsi; J, female fifth tarsomeres and claws; K, female spermatheca; L, female abdomen; M, male genitalia.

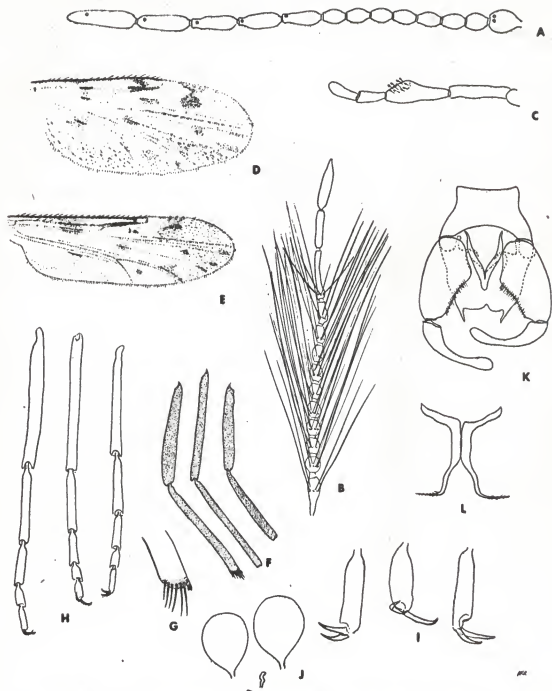


Figure 29.--Culicoides (Culicoides) yukonensis Hoffman: A, female antenna; B, male antenna; C, female palpus; D, female wing; E, male wing; F, female legs; G, enlarged hind tibial comb; H, female tarsi; I, female fifth tarsomeres and claws; J, female spermathecae; K, male genitalia; L, male parameres.

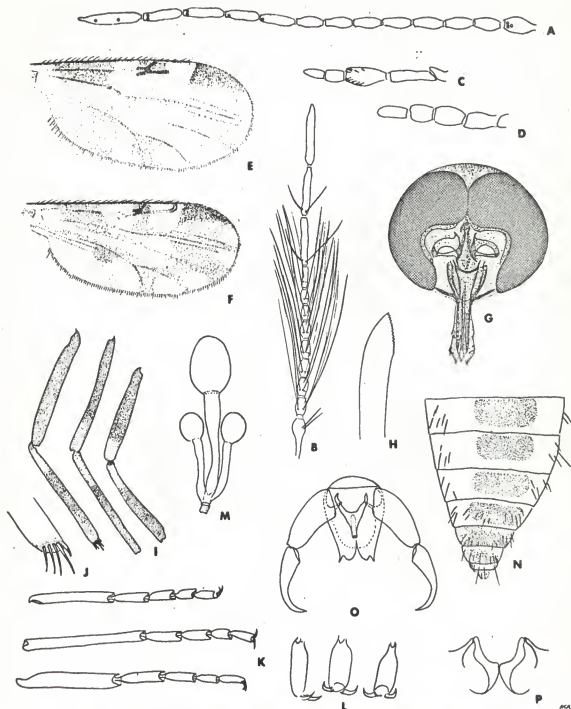


Figure 30.--*Culicoides (Trithecodes) flaviscutatus* W. & H.:
 A, female antenna; B, male antenna; C, female palpus; D, male palpus;
 E, female wing; F, male wing; G, female head; H, mandible; I, female
 legs; J, enlarged hind tibial comb; K, female tarsi; L, female fifth
 tarsomeres and claws; M, female spermathecae; N, female abdomen;
 O, male genitalia; P, male parameres.



Figure 31.--Culicoides (Haemophoructus) gemellus Macfie:
 A, female antenna; B, male antenna; C, female palpus; D, male palpus;
 E, female wing; F, male wing; G, female head; H, mandible; I, female
 legs; J, enlarged hind tibial comb; K, female tarsi; L, female fifth
 tarsomeres and claws; M, female spermathecae; N, female abdomen;
 O, male genitalia; P, male parameres.

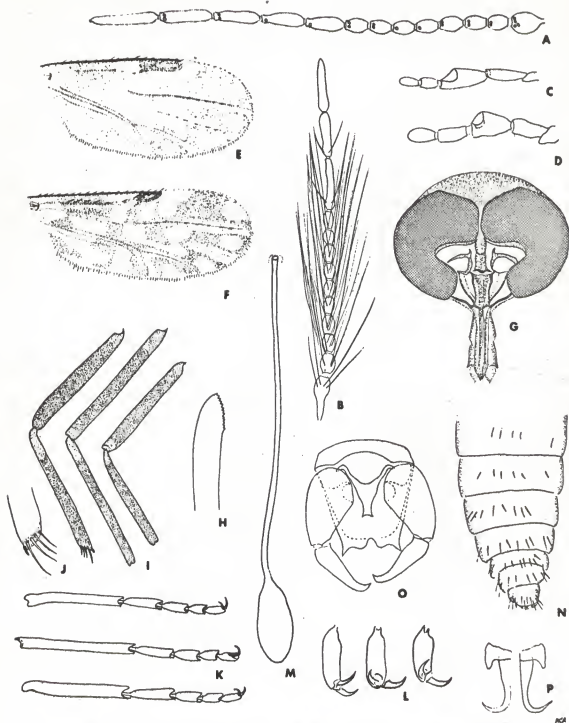


Figure 32.--*Culicoides (Meijerehelea) guttifer* (Meijere):

A, female antenna; B, male antenna; C, female palpus; D, male palpus; E, female wing; F, male wing; G, female head; H, mandible; I, female leg; J, enlarged hind tibial comb; K, female tarsi; L, female fifth tarsomeres and claws; M, female spermatheca; N, female abdomen; O, male genitalia; P, male parameres.

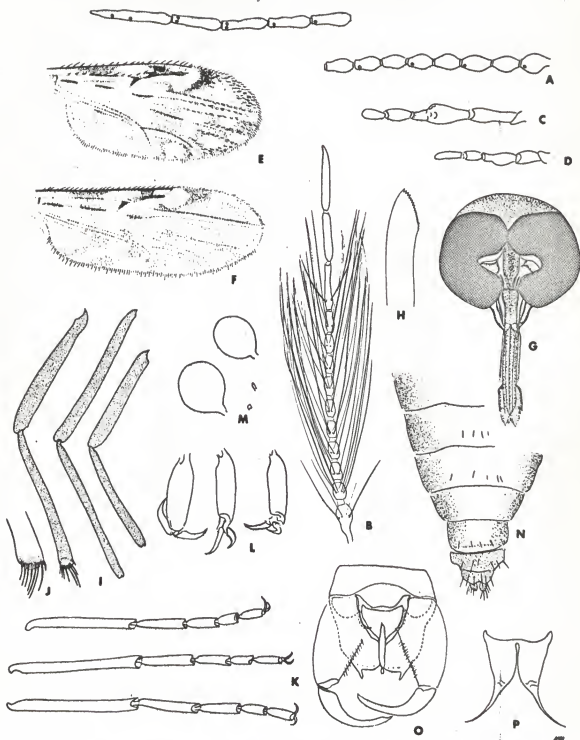


Figure 33.--*Culicoides (Hoffmania) insignis* Lutz: A, female antenna; B, male antenna; C, female palpus; D, male palpus; E, female wing; F, male wing; G, female head; H, mandible; I, female legs; J, enlarged hind tibial comb; K, female tarsi; L, female fifth tarsomeres and claws; M, female spermathecae; N, female abdomen; O, male genitalia; P, male parameres.

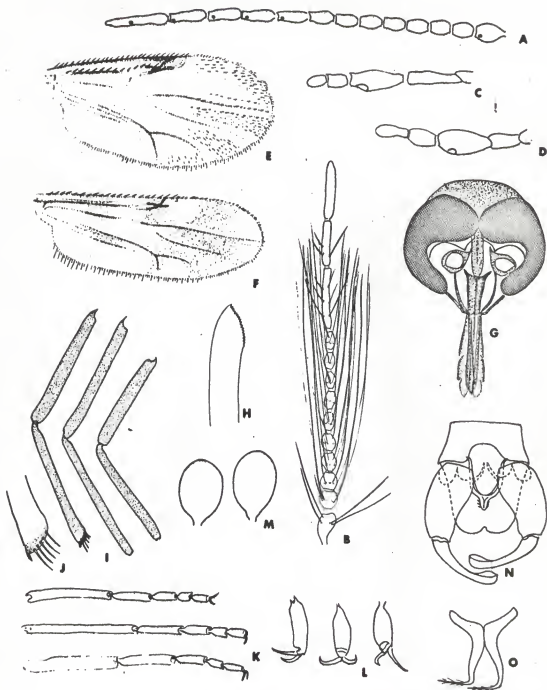


Figure 34.--*Culicoides (Avaritia) obsoletus* (Mg.): A, female antenna; B, male antenna; C, female palpus; D, male palpus; E, female wing; F, male wing; G, female head; H, mandible; I, female legs; J, enlarged hind tibial comb; K, female tarsi; L, female fifth tarso-meres and claws; M, female spermathecae; N, male genitalia; O, male parameres.

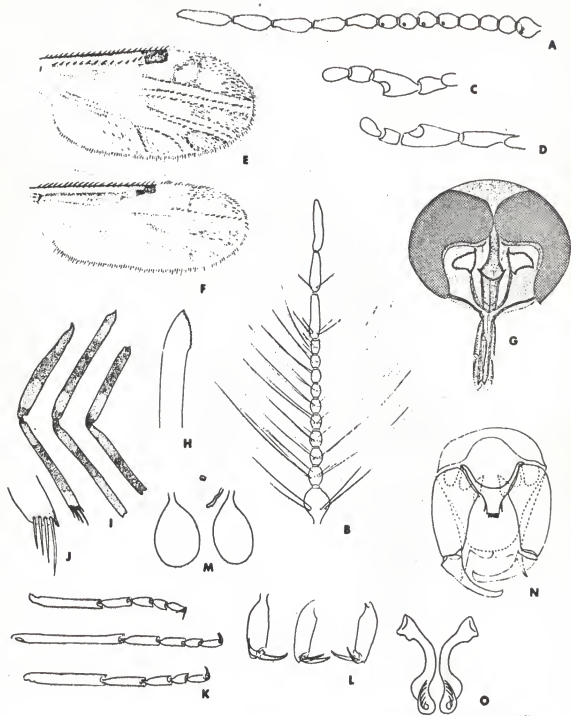


Figure 35.--*Culicoides (Oecacta) furens* (Poey): A, female antenna; B, male antenna; C, female palpus; D, male palpus; E, female wing; F, male wing; G, female head; H, mandible; I, female legs; J, enlarged hind tibial comb; K, female tarsi; L, female fifth tarsomeres and claws; M, female spermathecae; N, male genitalia; O, male parameres.

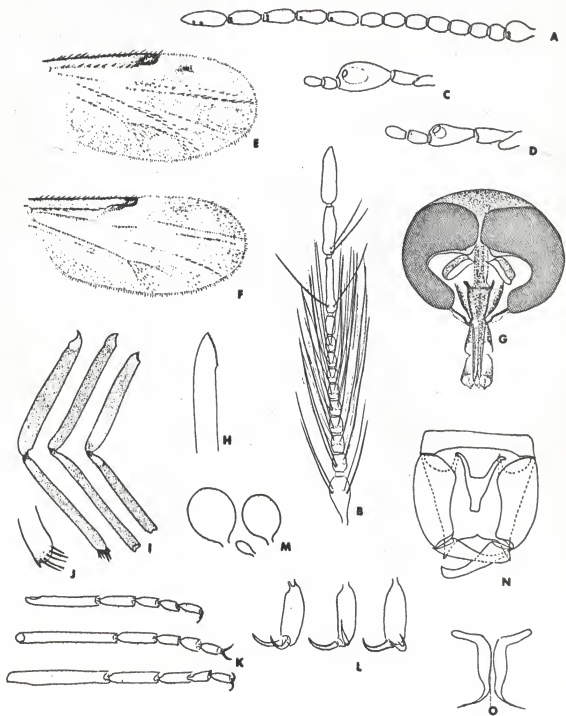


Figure 36.--*Culicoides (Drymodesmyia) copiosus* R. & H.: A, female antenna; B, male antenna; C, female palpus; D, male palpus; E, female wing; F, male wing; G, female head; H, mandible; I, female legs; J, enlarged hind tibial comb; K, female tarsi; L, female fifth tarsomeres and claws; M, female spermathecae; N, male genitalia; O, male parameres.

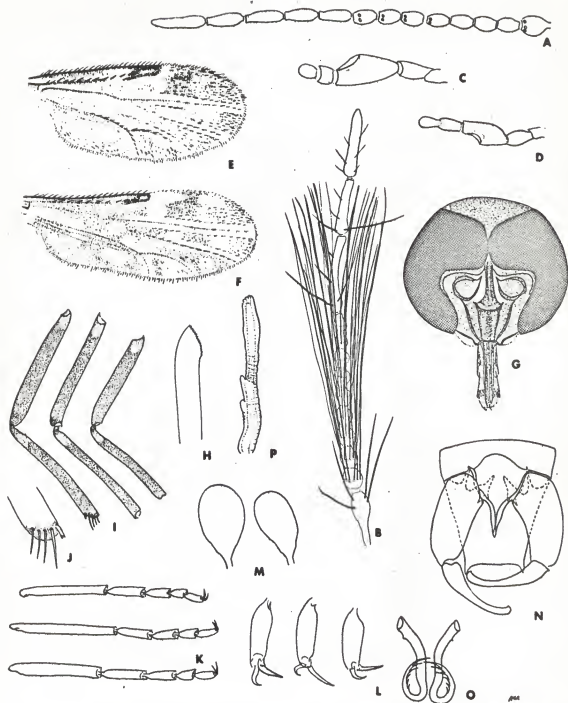


Figure 37.--Culicoides (Diphaeomyia) baueri Hoffman: A, female antenna; B, male antenna; C, female palpus; D, male palpus; E, female wing; F, male wing; G, female head; H, mandible; I, female legs; J, enlarged hind tibial comb; K, female tarsi; L, female fifth tarsomeres and claws; M, female spermathecae; N, male genitalia; O, male parameres; P, pupal respiratory organ.

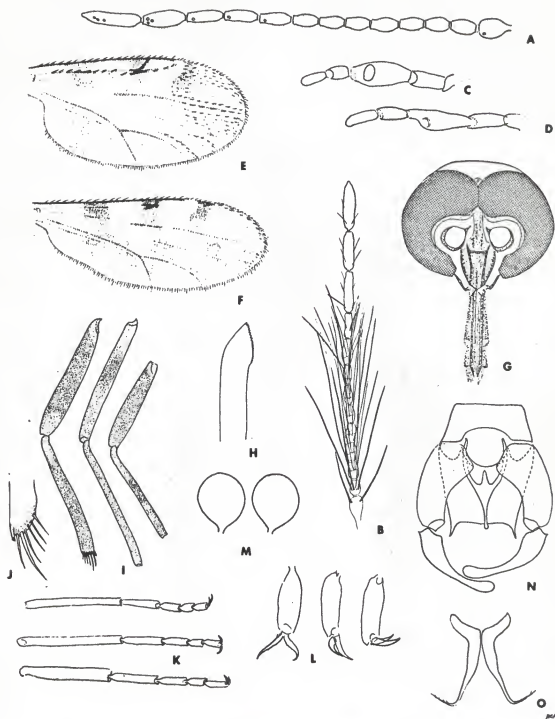


Figure 38.--Culicoides (Anilomyia) covagarciai Ortiz.: A, female antenna; B, male antenna; C, female palpus; D, male palpus; E, female wing; F, male wing; G, female head; H, mandible; I, female legs; J, enlarged hind tibial comb; K, female tarsi; L, female fifth tarso-meres and claws; M, female spermathecae; N, male genitalia; O, male parameres.

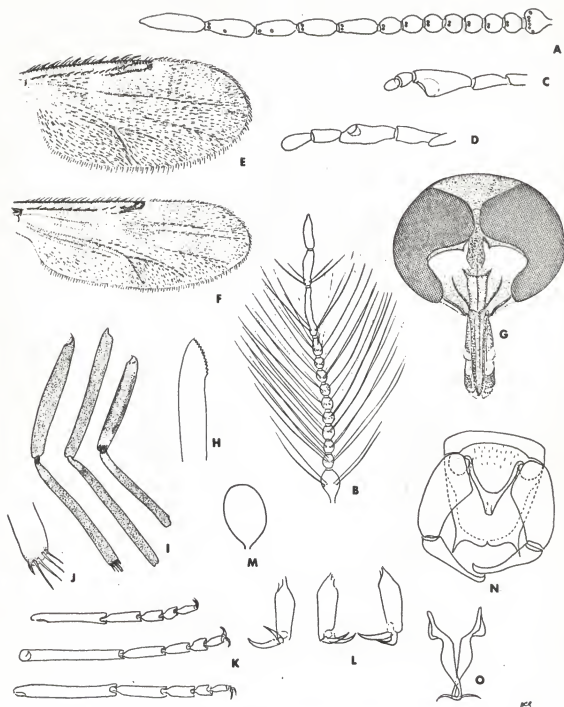


Figure 39.--Culicoides (Beltranmyia) crepuscularis Malloch:
 A, female antenna; B, male antenna; C, female palpus; D, male palpus;
 E, female wing; F, male wing; G, female head; H, mandible; I, female
 legs; J, enlarged hind tibial comb; K, female tarsi; L, female fifth
 tarsomeres and claws; M, female spermatheca; N, male genitalia;
 O, male parameres.

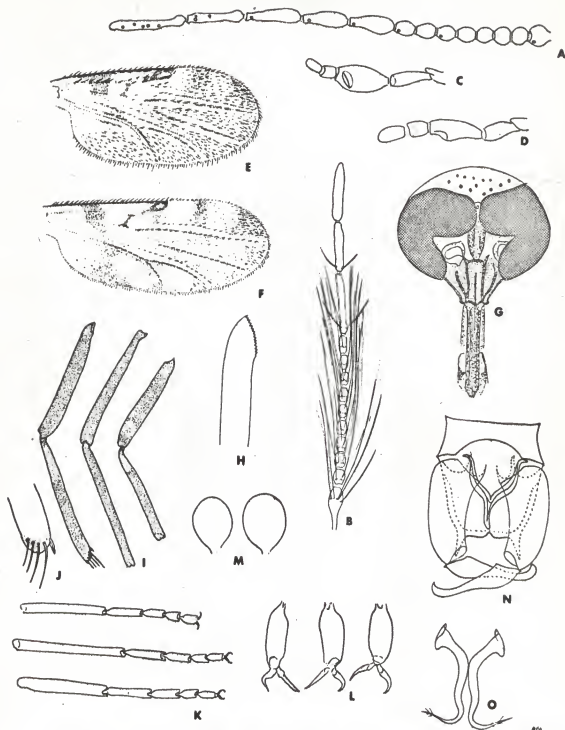


Figure 40.--*Culicoides* (*Glaphiromyia*) *scopus* R. & H.: A, female antenna; B, male antenna; C, female palpus; D, male palpus; E, female wing; F, male wing; G, female head; H, mandible; I, female legs; J, enlarged hind tibial comb; K, female tarsi; L, female fifth tarsomeres and claws; M, female spermathecae; N, male genitalia; O, male parameres.

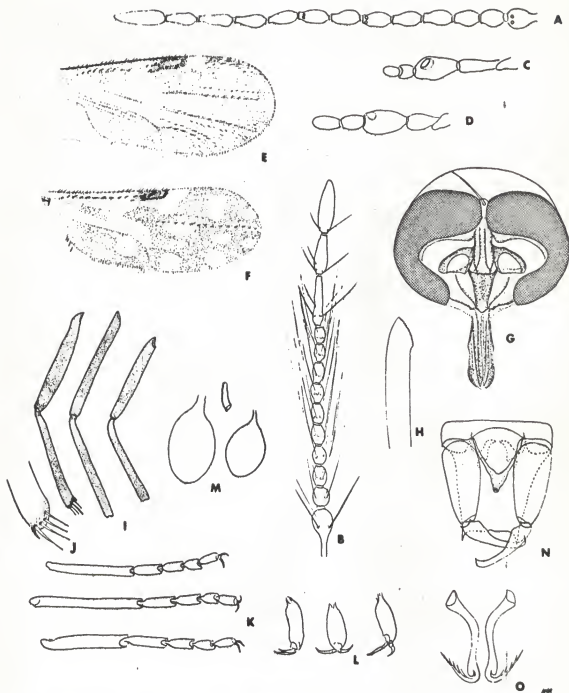


Figure 41.--Culicoides (Haematomyidium) paraensis (Goeldi):
 A, female antenna; B, male antenna; C, female palpus; D, male palpus;
 E, female wing; F, male wing; G, female head; H, mandible; I, female
 legs; J, enlarged hind tibial comb; K, female tarsi; L, female fifth
 tarsomeres and claws; M, female spermathecae; N, male genitalia;
 O, male parameres.

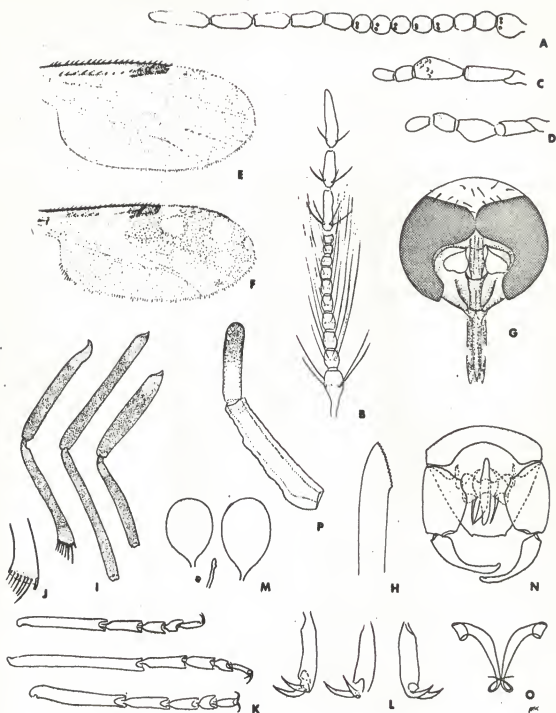


Figure 42.--Culicoides (Macfiella) phlebotomus (Will.): A, female antenna; B, male antenna; C, female palpus; D, male palpus; E, female wing; F, male wing; G, female head; H, mandible; I, female legs; J, enlarged hind tibial comb; K, female tarsi; L, female fifth tarsomeres and claws; M, female spermathecae; N, male genitalia; O, male parameres; P, pupal respiratory organ.

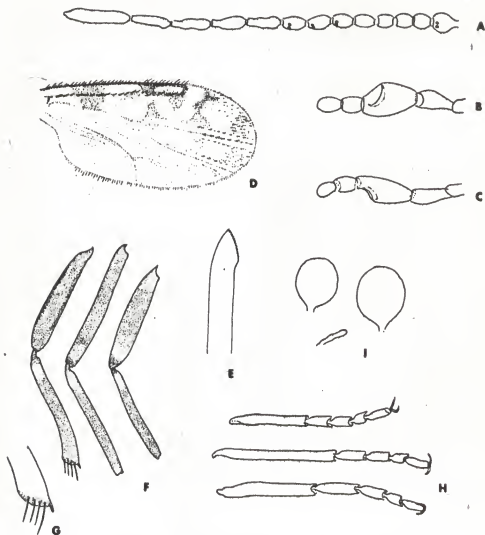


Figure 43.--Culicoides (Mataemyia) motingaensis W. & H.:
 A, female antenna; B, female palpus; C, male palpus; D, female wing;
 E, mandible; F, female legs; G, enlarged hind tibial comb; H, female
 tarsi; I, female spermathecae.

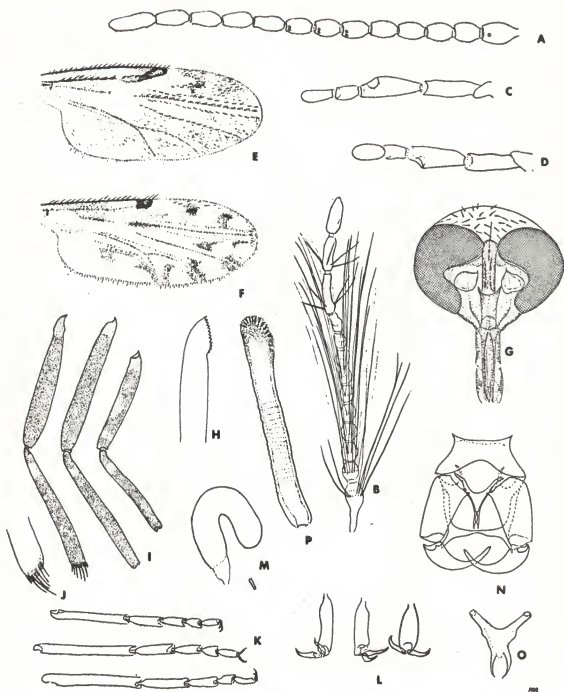


Figure 44.--*Culicoides (Monoculicoides) variipennis* (Coq.):
 A, female antenna; B, male antenna; C, female palpus; D, male palpus;
 E, female wing; F, male wing; G, female head; H, mandible; I, female
 legs; J, enlarged hind tibial comb; K, female tarsi; L, female fifth
 tarsomeres and claws; M, female spermatheca; N, male genitalia;
 O, male paramere; P, pupal respiratory organ.

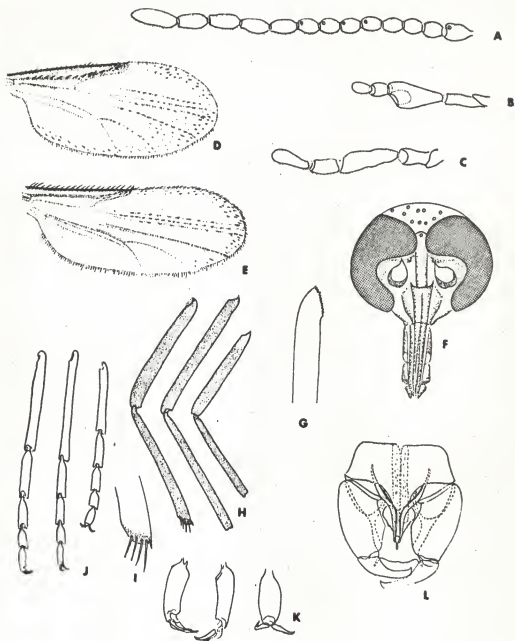


Figure 45.--Culicoides (Selfia) hieroglyphicus Malloch:
 A, female antenna; B, female palpus; C, male palpus; D, female wing;
 E, male wing; F, female head; G, mandible; H, female legs; I, enlarged
 hind tibial comb; J, female tarsi; K, female fifth tarsomeres and claws;
 L, male genitalia.

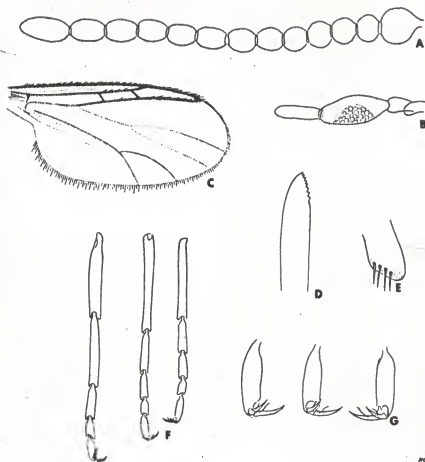


Figure 46.--*Austroconops mcmilland* Wirth & Lee: A, female antenna; B, female palpus; C, female wing; D, mandible; E, enlarged hind tibial comb; F, female tarsi; G, female fifth tarsomeres and claws.

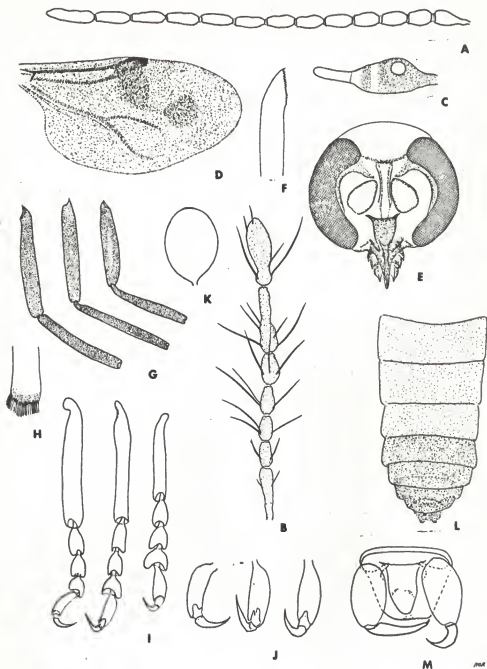


Figure 47.--*Camptopterohoelea hoogstraali* W. & H.: A, female antenna; B, male antenna; C, female palpus; D, female wing; E, female head; F, mandible; G, female legs; H, enlarged hind tibial comb; I, female tarsi; J, female fifth tarsomeres and claws; K, female spermatheca; L, female abdomen; M, male genitalia.

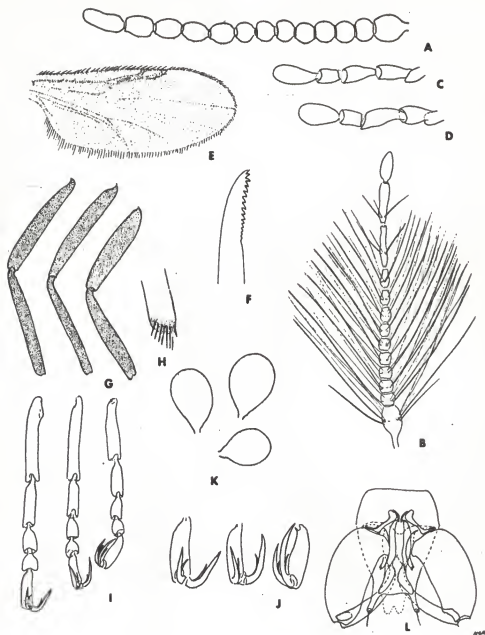


Figure 48.--Ceratopogon (Ceratopogon) culicoidithorax Hoffman:
 A, female antenna; B, male antenna; C, female palpus; D, male palpus;
 E, female wing; F, mandible; G, female legs; H, enlarged hind tibial
 comb; I, female tarsi; J, female fifth tarsomeres and claws; K, female
 spermathecae; L, male genitalia.

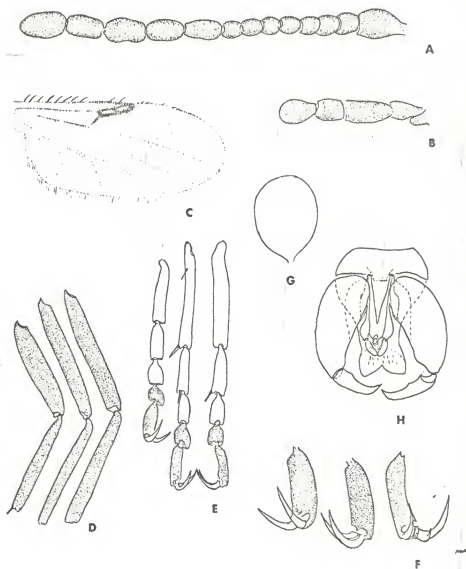


Figure 49.--Ceratopogon (Isohelea) stigmalis Coq.: A, female antenna; B, female palpus; C, female wing; D, female legs; E, female tarsi; F, female fifth tarsomeres and claws; G, female spermatheca; H, male genitalia.



Figure 50.--*Alluaudomyia bella* (Coq.): A, female antenna; B, male antenna; C, female palpus; D, male palpus; E, female wing; F, male wing; G, female head; H, female legs; I, enlarged hind tibial comb; J, female tarsi; K, male tarsi; L, female fifth tarsomeres and claws; M, male fifth tarsomeres; N, female spermatheca; O, male genitalia; P, male parameres.

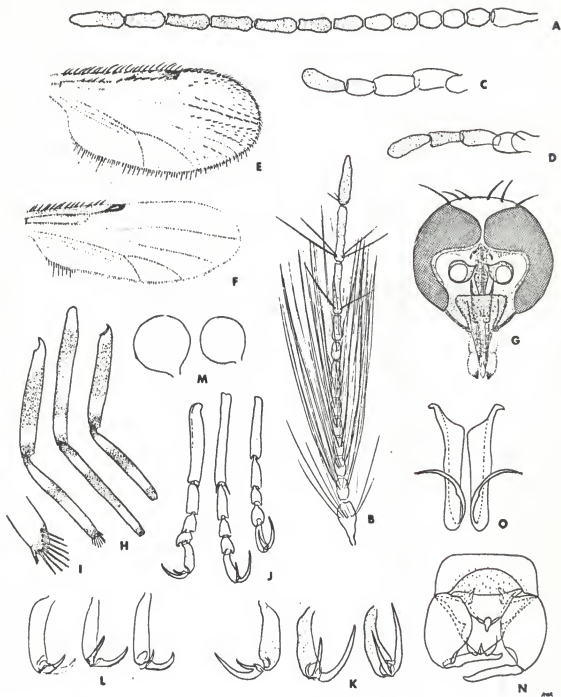


Figure 51.--*Alluaudomyia parva* Wirth: A, female antenna; B, male antenna; C, female palpus; D, male palpus; E, female wing; F, male wing; G, female head; H, female legs; I, enlarged hind tibial comb; J, female tarsi; K, female fifth tarsomeres and claws; L, male fifth tarsomeres; M, female spermathecae; N, male genitalia; O, male parameres.

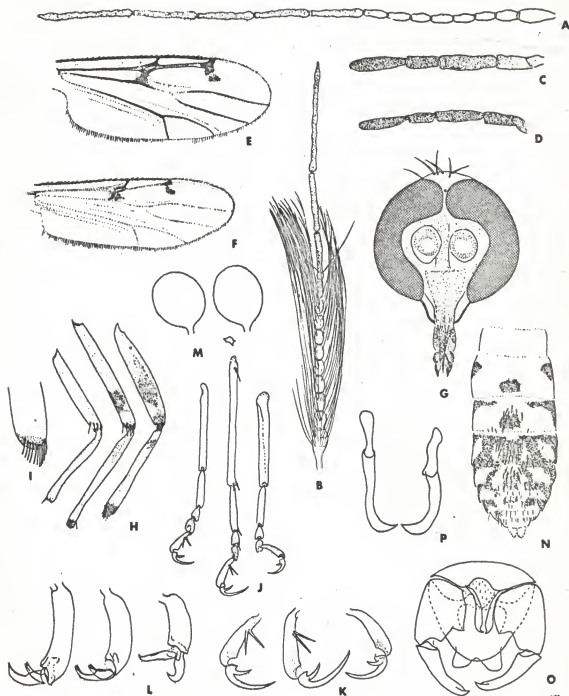


Figure 52.--*Stilobezzia* (*Stilobezzia*) *festiva* K.: A, female antenna; B, male antenna; C, female palpus; D, male palpus; E, female wing; F, male wing; G, female head; H, female legs; I, enlarged hind tibial comb; J, female tarsi; K, female fifth tarsomeres and claws; L, male fifth tarsomeres; M, female spermathecae; N, female abdomen; O, male genitalia; P, male parameres.

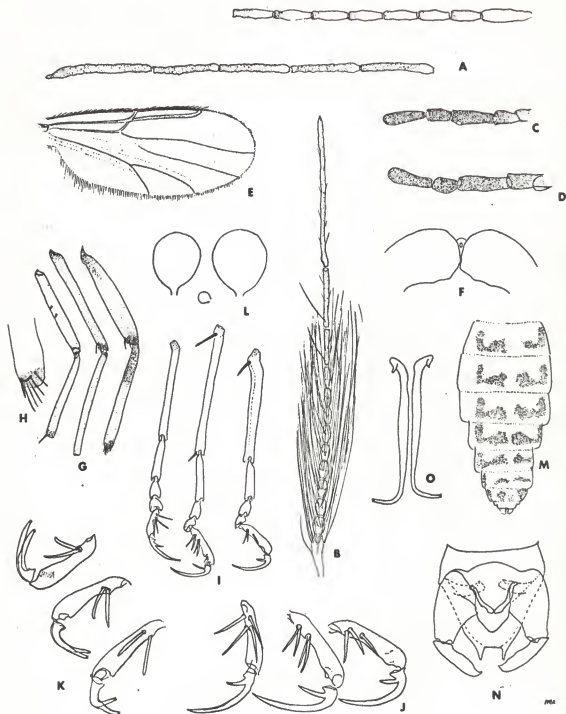


Figure 53.--*Stilobezzia (Eukraiohelea) elegantula* (Joh.):
 A, female antenna; B, male antenna; C, female palpus; D, male palpus;
 E, female wing; F, female eye separation; G, female legs; H, enlarged
 hind tibial comb; I, female tarsi; J, female fifth tarsomeres and
 claws; K, male fifth tarsomeres; L, female spermathecae; M, female
 abdomen; N, male genitalia; O, male parameres.

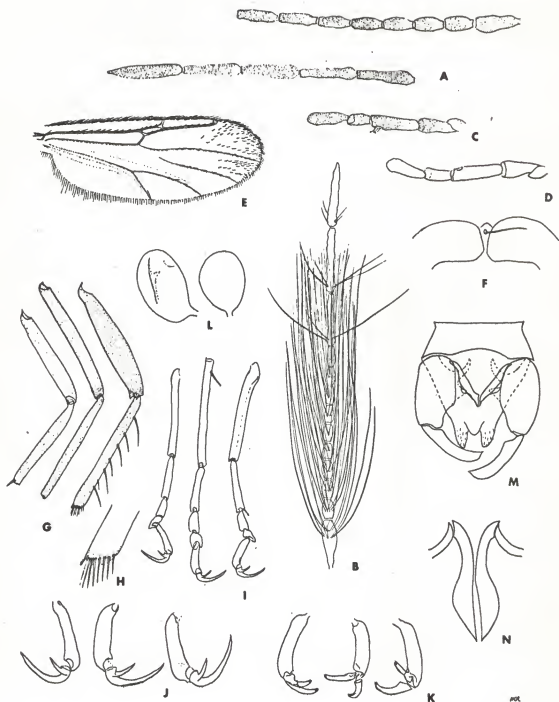


Figure 54.--*Stilobezzia* (*Neostilobezzia*) *lutea* (Malloch):
 A, female antenna; B, male antenna; C, female palpus; D, male palpus;
 E, female wing; F, female eye separation; G, female legs; H, enlarged
 hind tibial comb; I, female tarsi; J, female fifth tarsomeres and
 claws; K, male fifth tarsomeres, L, female spermathecae; M, male
 genitalia; N, male parameres.

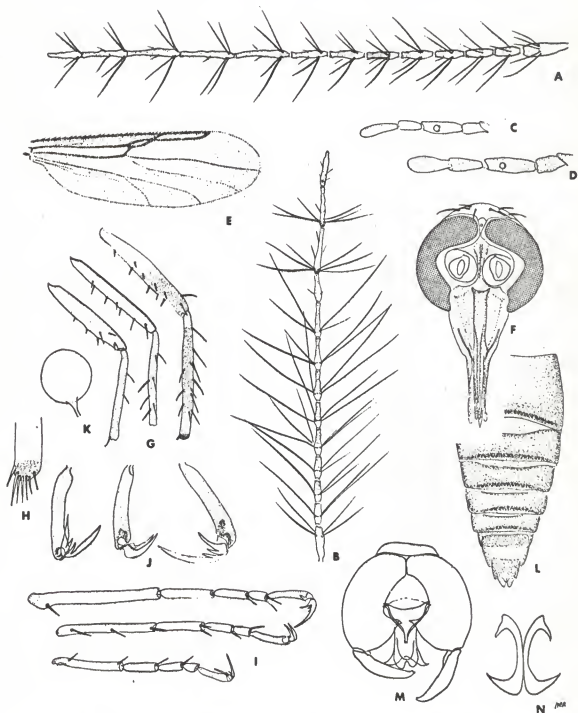


Figure 55.--*Echinohelea lanei* Wirth: A, female antenna; B, male antenna; C, female palpus; D, male palpus; E, female wing; F, female head; G, female legs; H, enlarged hind tibial comb; I, female tarsi; J, female fifth tarsomeres and claws; K, female spermatheca; L, female abdomen; M, male genitalia; N, male parameres.



Figure 56.--Monohalea (Monohalea) hieroglyphica K.: A, female antenna; B, male antenna; C, female palpus; D, female wing; E, female head; F, female legs; G, enlarged hind tibial comb; H, female tarsi; I, female fifth tarsomeres and claws; J, male fifth tarsomeres; K, female spermathecae; L, male genitalia; M, male parameres.

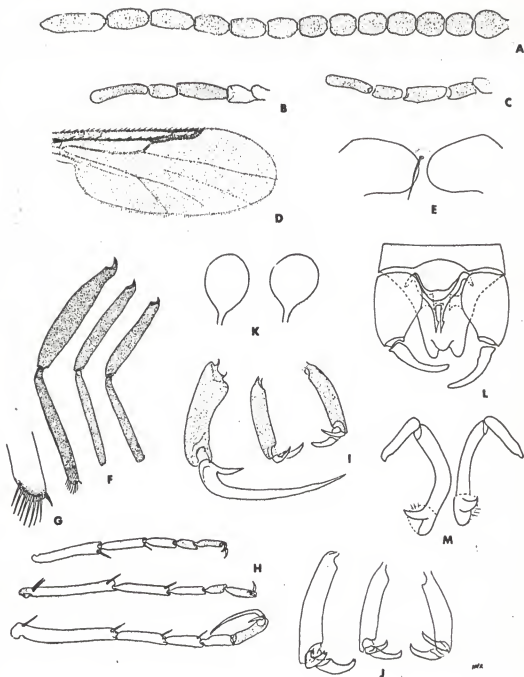


Figure 57.--*Monohalea* (*Schizohalea*) *leucopeza* (Mg.): A, female antenna; B, female palpus; C, male palpus; D, female wing; E, female eye separation; F, female legs; G, enlarged hind tibial comb; H, female tarsi; I, female fifth tarsomeres and claws; J, male fifth tarsomeres; K, female spermathecae; L, male genitalia; M, male parameres.

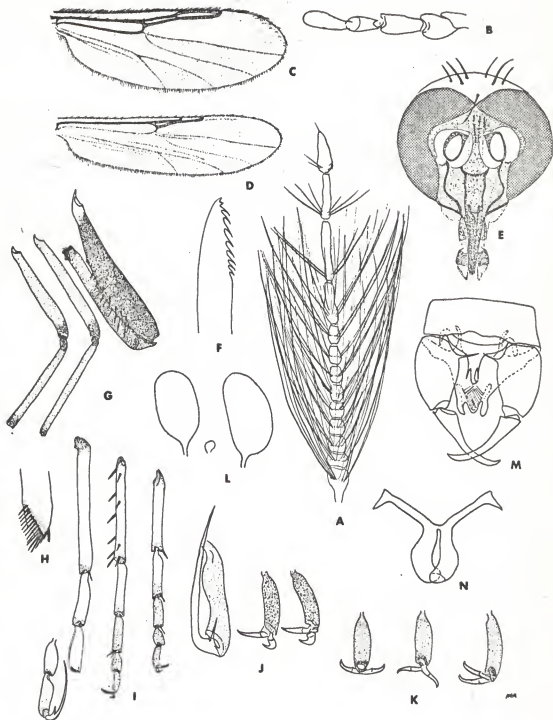


Figure 58.--*Serromyia femorata* (Mg.): A, male antenna; B, male palpus; C, female wing; D, male wing; E, female head; F, mandible; G, female legs; H, enlarged hind tibial comb; I, female tarsi; J, female fifth tarsomeres and claws; K, male fifth tarsomeres; L, female spermathecae; M, male genitalia; N, male parameres.

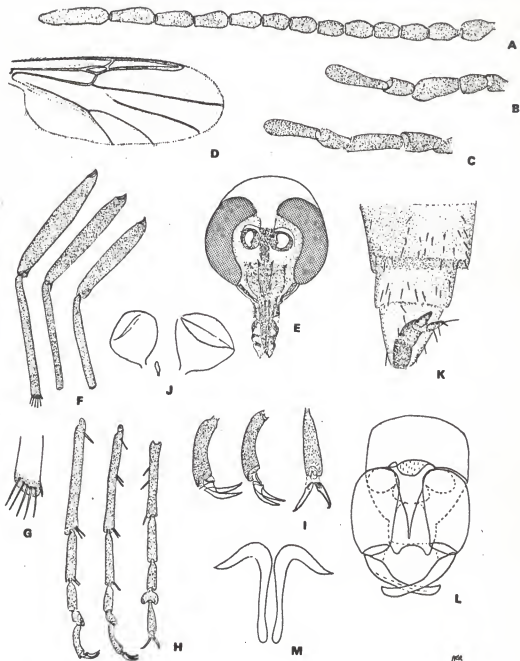


Figure 59.--*Macrurohelea setosa* Wirth: A, female antenna; B, female palpus; C, male palpus; D, female wing; E, female head; F, female legs; G, enlarged hind tibial comb; H, female tarsi; I, female fifth tarsomeres and claws; J, female spermathecae; K, female abdomen; L, male genitalia; M, male parameres.



Figure 60.--*Parabezzia petiolata* Mall.: A, female antenna; B, male antenna; C, female palpus; D, male palpus; E, female wing; F, female head; G, male coxae; H, female legs; I, enlarged hind tibial comb; J, female tarsi; K, female fifth tarsomeres and claws; L, male fifth tarsomeres; M, female spermathecae; N, male genitalia; O, female pupal respiratory organ; P, male pupal respiratory organ; Q, female anal segment; R, male anal segment.

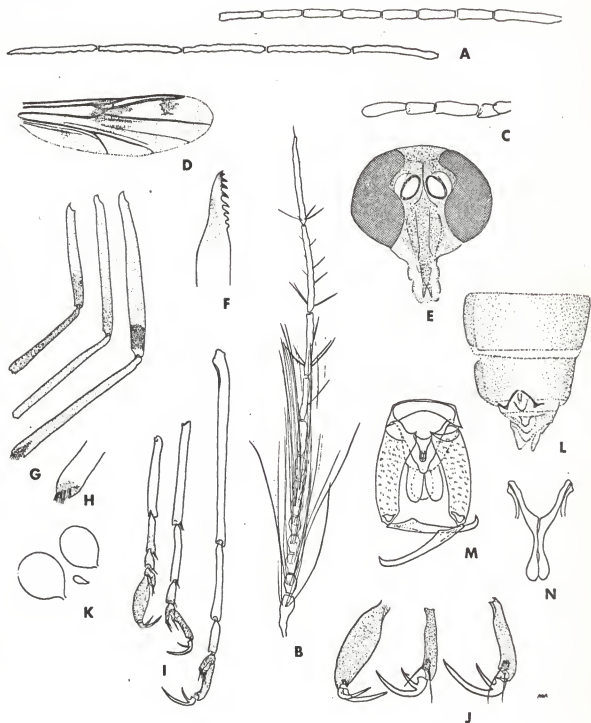


Figure 61.--*Clinohoelea bimaculata* (Loew): A, female antenna; B, male antenna; C, female palpus; D, female wing; E, female head; F, mandible; G, female legs; H, enlarged hind tibial comb; I, female tarsi; J, female fifth tarsomeres and claws; K, female spermathecae; L, ventral view of female abdomen; M, male genitalia; N, male parameres.

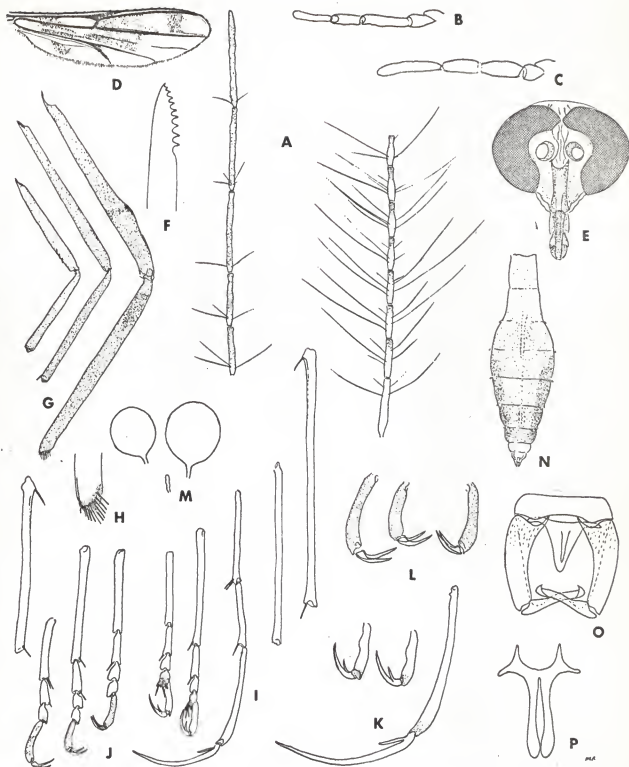


Figure 62.--*Tetrabezzia pictipennis* (K.): A, female antenna; B, female palpus; C, male palpus; D, female wing; E, female head; F, mandible; G, female legs; H, enlarged hind tibial comb; I, female tarsi; J, male tarsi; K, female fifth tarsomeres and claws; L, male fifth tarsomeres; M, female spermathecae; N, female abdomen; O, male genitalia; P, male parameres.

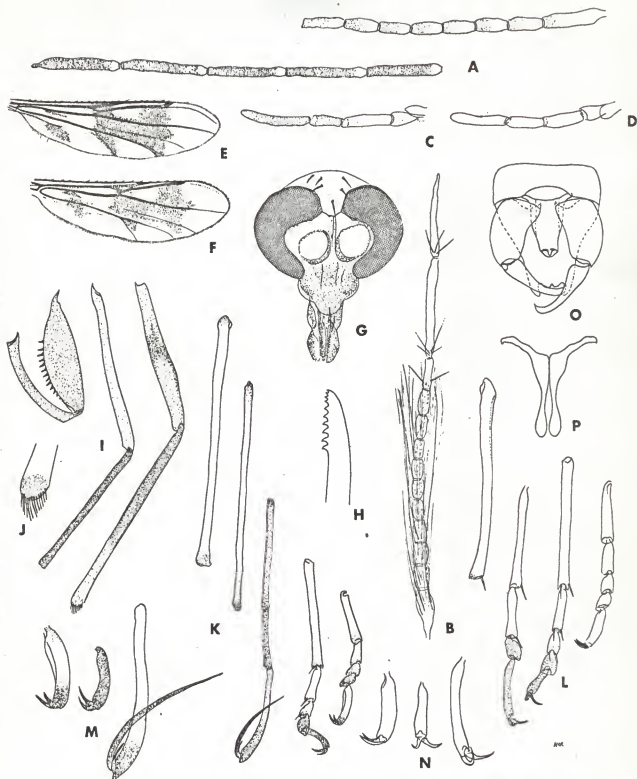


Figure 63.--*Heteromyia fasciata* Say: A, female antenna; C, female palpus; E, female wing; G, female head; H, mandible; I, female legs; J, enlarged hind tibial comb; K, female tarsi; M, female fifth tarsomeres and claws. *Heteromyia* sp. (male): B, male antenna; D, male palpus; F, male wing; L, male tarsi; N, male fifth tarsomeres; O, male genitalia; P, male parameres.

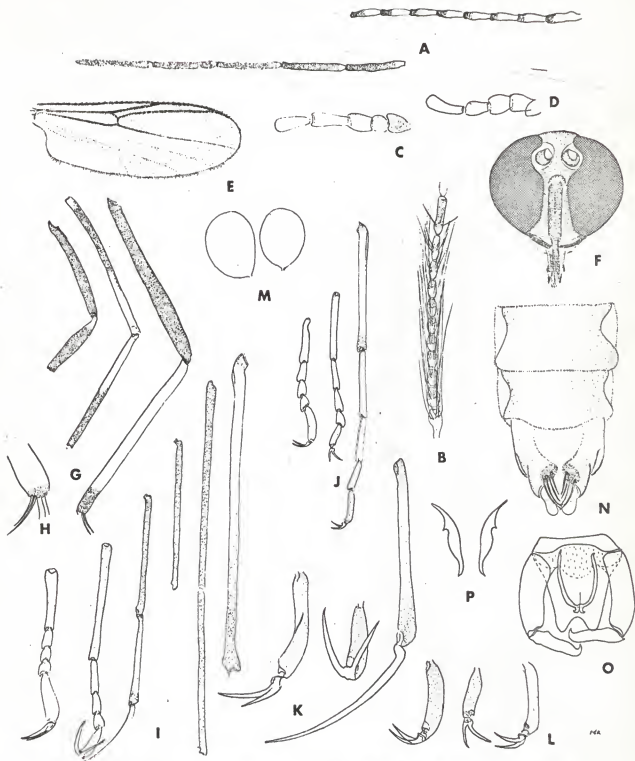


Figure 64.--*Pellucidomyia* sp.: A, female antenna; B, proximal segments of male antenna; C, female palpus; D, male palpus; E, female wing; F, female head; G, female legs; H, enlarged hind tibial comb; I, female tarsi; J, male tarsi; K, female fifth tarsomeres and claws; L, male fifth tarsomeres; M, female spermathecae; N, female abdomen; O, male genitalia; P, male parameres.



Figure 65.--*Neurochelea nigra* Wirth: A, female antenna; B, male antenna; C, female palpus; D, male palpus; E, female wing; F, female head; G, mandible; H, female legs; I, enlarged hind tibial comb; J, female tarsi; K, female fifth tarsomeres and claws; L, female spermathecae; M, male genitalia; N, male parameres.



Figure 66.--*Johannsenomyia argentata* (Loew): A, female antenna; B, male antenna; C, female palpus; D, male palpus; E, female wing; F, female head; G, anterior mesonotum; H, female legs; I, enlarged hind tibial comb; J, female tarsi; K, female fifth tarsomeres and claws; L, male fifth tarsomeres; M, female spermathecae; N, female abdomen; O, male genitalia; P, male parameres.

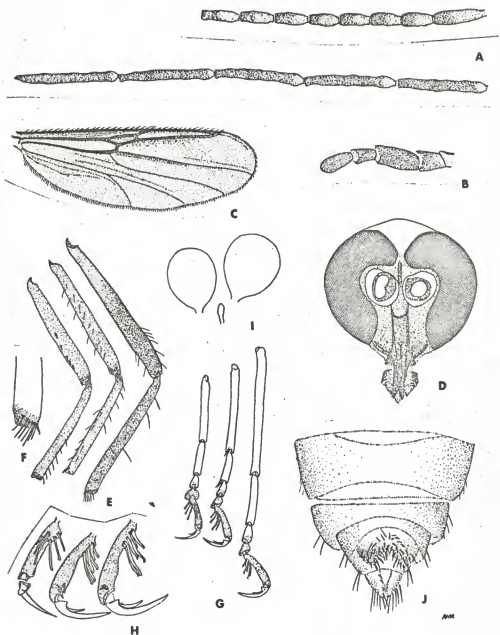


Figure 67.--*Xenohoelea tonnoiri* Lee: A, female antenna; B, female palpus; C, female wing; D, female head; E, female legs; F, enlarged hind tibial comb; G, female tarsi; H, female fifth tarsomeres and claws; I, female spermathecae; J, ventral view of female abdomen.

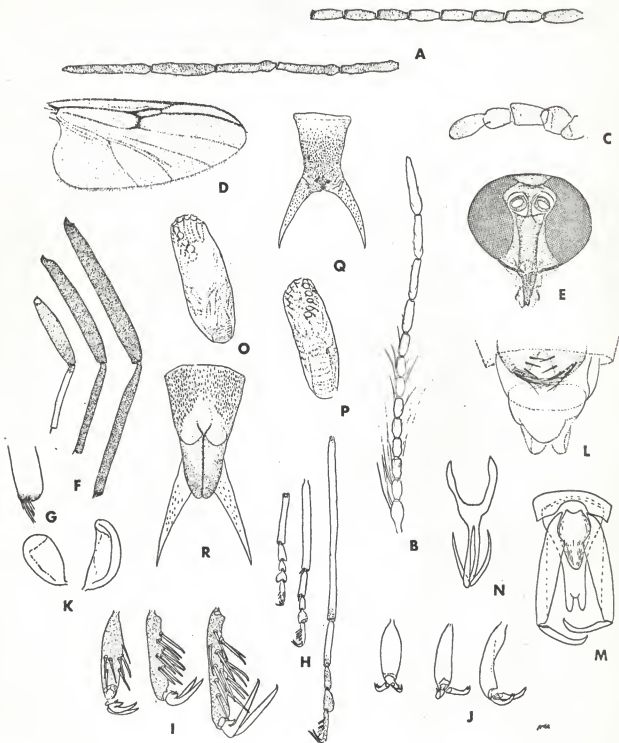


Figure 68.--*Jenkinshalea magnipennis* (Joh.): A, female antenna; B, male antenna; C, female palpus; D, female wing; E, female head; F, female legs; G, enlarged hind tibial comb; H, female tarsi; I, female fifth tarsomeres and claws; J, male fifth tarsomeres; K, female spermathecae; L, female abdomen; M, male genitalia; N, male parameres; O, female pupal respiratory organ; P, male pupal respiratory organ; Q, female anal segment; R, male anal segment.

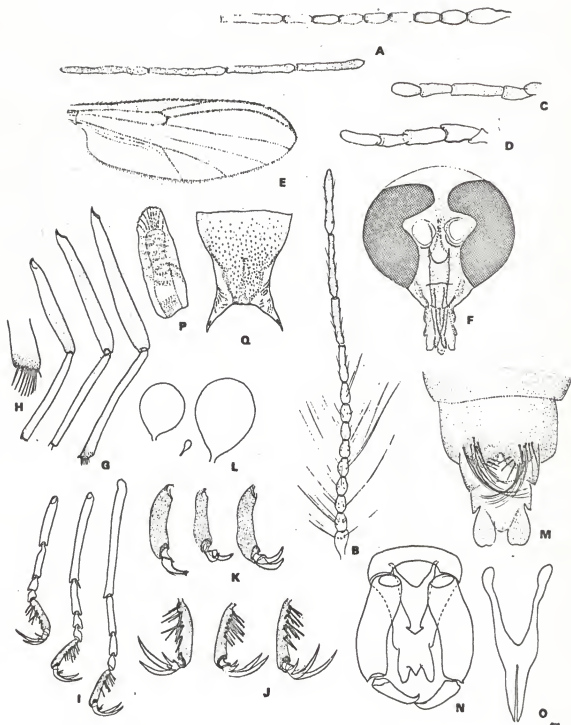


Figure 69.--*Probezzia pallida* Malloch: A, female antenna; B, male antenna; C, female palpus; D, male palpus; E, female wing; F, female head; G, female legs; H, enlarged hind tibial comb; I, female tarsi; J, female fifth tarsomeres and claws; K, male fifth tarsomeres; L, female spermathecae; M, female abdomen; N, male genitalia; O, male paramere; P, pupal respiratory organ; Q, male anal segment.

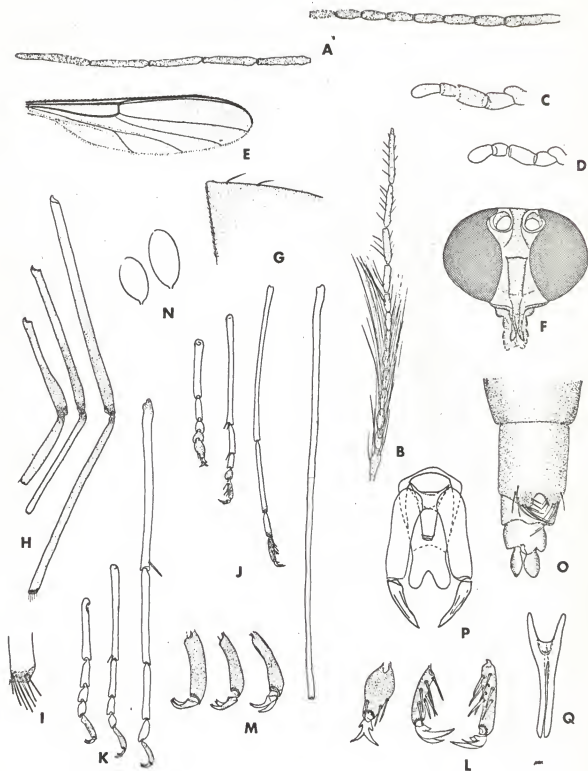


Figure 70.--*Calyptopogon gibbosus* (Wied.): A, female antenna; B, male antenna; C, female palpus; D, male palpus; E, female wing; F, female head; G, anterior mesonotum; H, female legs; I, enlarged hind tibial comb; J, female tarsi; K, male tarsi; L, female fifth tarsomeres and claws; M, male fifth tarsomeres; N, female spermathecae; O, female abdomen; P, male genitalia; Q, male parameres.



Figure 71.---*Sphaeromias* (*Sphaeromias*) *longipennis* (Loew):

A, female antenna; B, male antenna; C, female palpus; D, male palpus; E, female wing; F, female head; G, anterior mesonotum; H, female legs; I, enlarged hind tibial comb; J, female tarsi; K, female fifth tarsomeres and claws; L, male fifth tarsomeres; M, female spermathecae; N, ventral view of female abdomen; O, male genitalia; P, male paramere; Q, pupal respiratory organ; R, pupal abdominal segment; S, female anal segment; T, male anal segment.

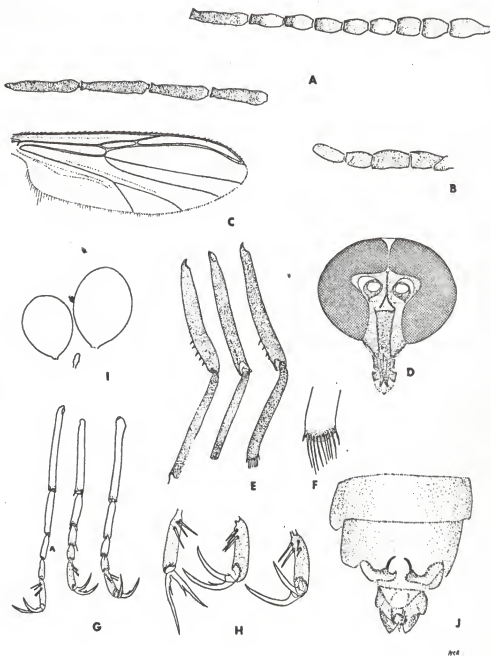


Figure 72.--Sphaeromidas (Homohoelea) barkudensis Edwards:
 A, female antenna; B, female palpus; C, female wing; D, female head;
 E, female legs; F, enlarged hind tibial comb; G, female tarsi; H,
 female fifth tarsomeres and claws; I, female spermathecae; J, ventral
 view of female abdomen.

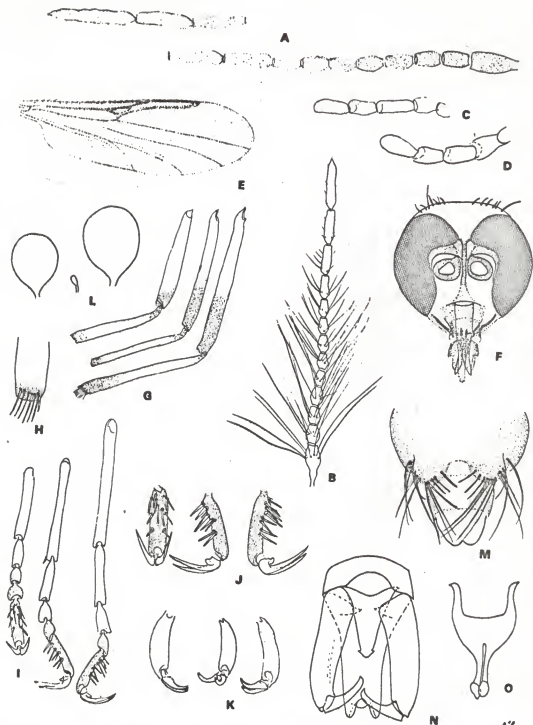


Figure 73.--*Mallochohelea albibasis* (Mall.): A, female antenna; B, male antenna; C, female palpus; D, male palpus; E, female wing; F, female head; G, female legs; H, enlarged hind tibial comb; I, female tarsi; J, female fifth tarsomeres and claws; K, male fifth tarsomeres; L, female spermathecae; M, female abdomen; N, male genitalia; O, male paramere.

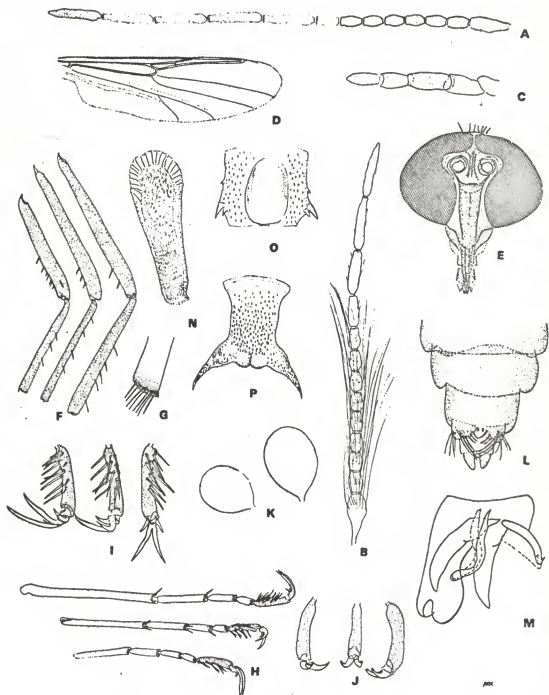


Figure 74.--*Nilobezzia schwarzii* (Coq.): A, female antenna; B, male antenna; C, female palpus; D, female wing; E, female head; F, female legs; G, enlarged hind tibial comb; H, female tarsi; I, female fifth tarsomeres and claws; J, male fifth tarsomeres; K, female spermathecae; L, female abdomen; M, male genitalia; N, pupal respiratory organ; O, pupal seventh abdominal segment and glandular disc; P, pupal anal segment.

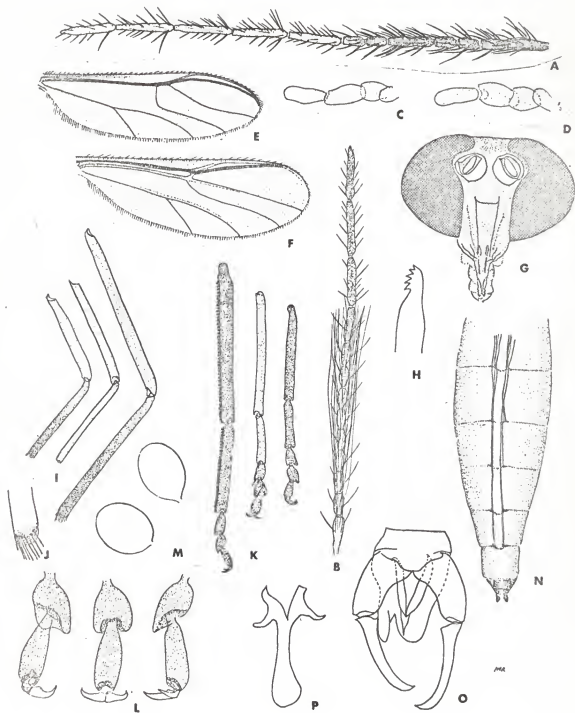


Figure 75.--*Stenoxenus insigninervis* Macfie: A, female antenna; B, male antenna; C, female palpus; D, male palpus; E, female wing; F, male wing; G, female head; H, mandible; I, female legs; J, enlarged hind tibial comb; K, female tarsi; L, female fourth and fifth tarsomeres and claws; M, female spermathecae; N, female abdomen; O, male genitalia; P, male paramere.

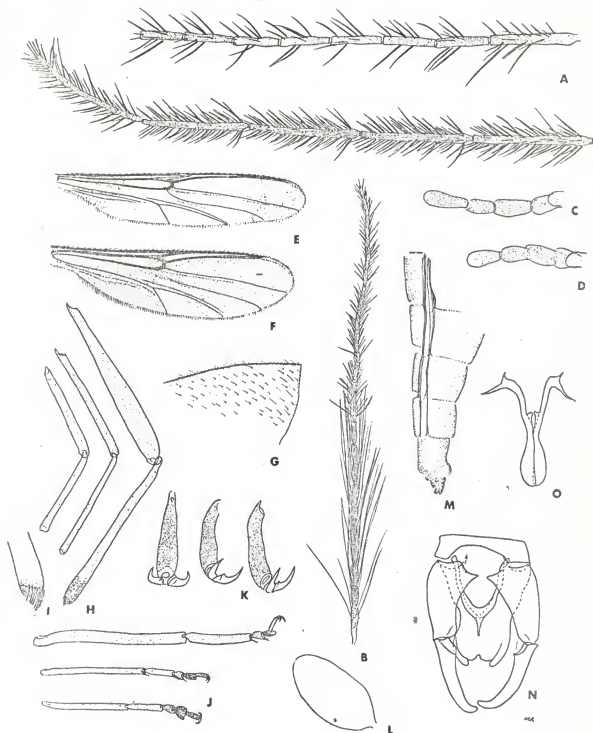


Figure 76.--*Paryphoconus angustipennis* Enderlein: A, female antenna; B, male antenna; C, female palpus; D, male palpus; E, female wing; F, male wing; G, anterior mesonotum; H, female legs; I, enlarged hind tibial comb; J, female tarsi; K, female fifth tarsomeres and claws; L, female spermatheca; M, female abdomen; N, male genitalia; O, male parameres.

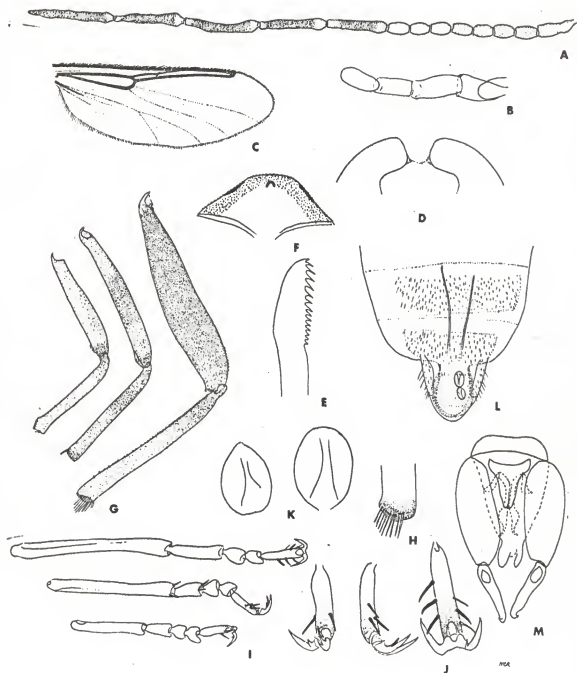


Figure 77.--*Pachyhelea pachymera* (Will.): A, female antenna; B, female palpus; C, female wing; D, female eye separation; E, mandible; F, front view of mesonotum; G, female legs; H, enlarged hind tibial comb; I, female tarsi; J, female fifth tarsomeres and claws; K, female spermathecae; L, female abdomen; M, male genitalia.

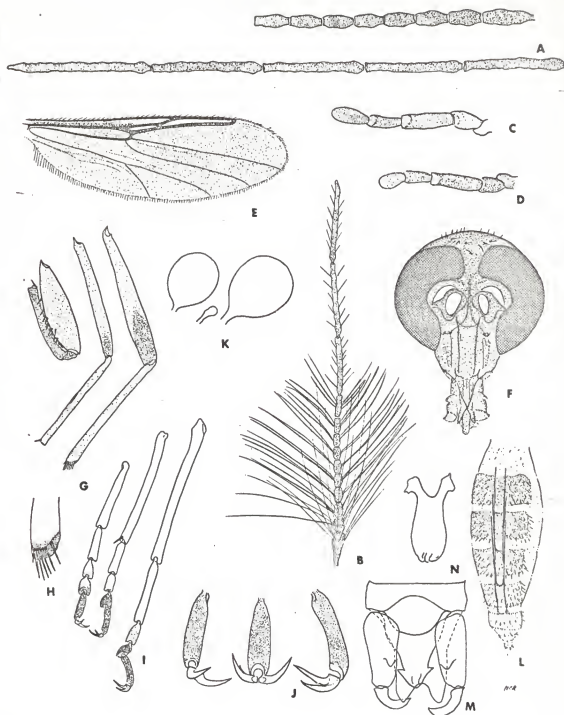


Figure 78.--*Palpomyia plebeia* (Loew): A, female antenna; B, male antenna; C, female palpus; D, male palpus; E, female wing; F, female head; G, female legs; H, enlarged hind tibial comb; I, female tarsi; J, female fifth tarsomeres and claws; K, female spermathecae; L, female abdomen; M, male genitalia; N, male paramere.

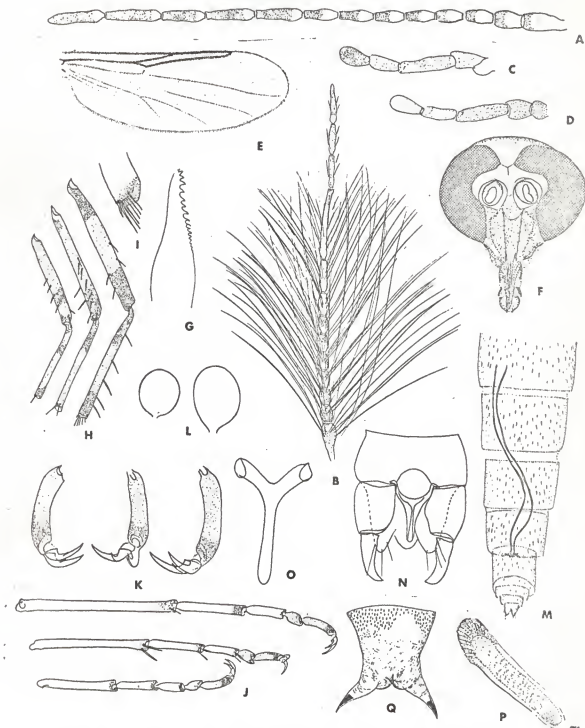


Figure 79.--*Bezzia* (*Bezzia*) *setulosa* (Loew): A, female antenna; B, male antenna; C, female palpus; D, male palpus; E, female wing; F, female head; G, mandible; H, female legs; I, enlarged hind tibial comb; J, female tarsi; K, female fifth tarsomeres and claws; L, female spermathecae; M, female abdomen; N, male genitalia; O, male paramere; P, pupal respiratory organ; Q, pupal anal segment.

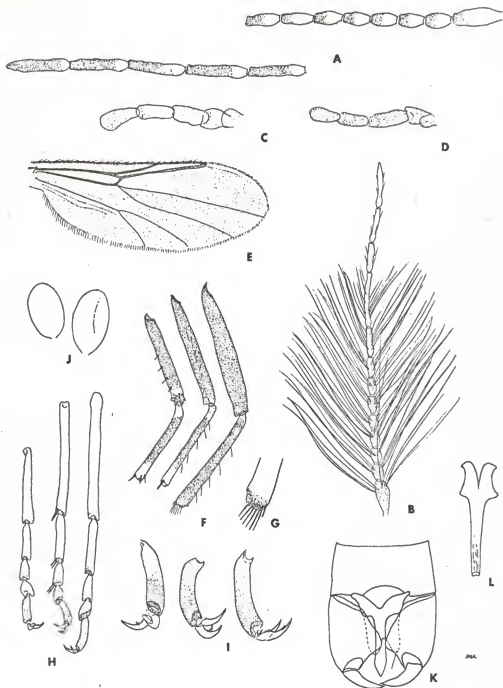


Figure 80.--*Bezzia* (*Pseudobezzia*) *flavitarsis* (Mall.):

A, female antenna; B, male antenna; C, female palpus; D, male palpus; E, female wing; F, female legs; G, enlarged hind tibial comb; H, female tarsi; I, female fifth tarsomeres and claws; J, female spermathecae; K, male genitalia; L, male paramere.

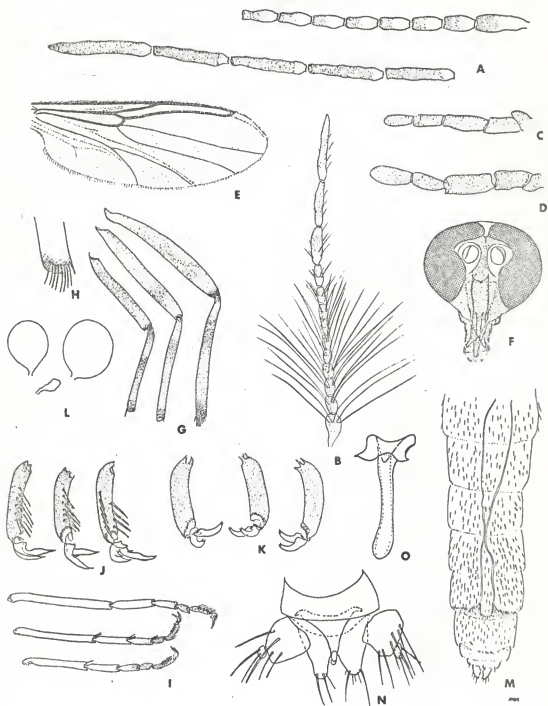


Figure 81.--*Phaenobezzia pistiae* (I. & M.): A, female antenna; B, male antenna; C, female palpus; D, male palpus; E, female wing; F, female head; G, female legs; H, enlarged hind tibial comb; I, female tarsi; J, female fifth tarsomeres and claws; K, male fifth tarsomeres; L, female spermathecae; M, female abdomen; N, male genitalia; O, male paramere.

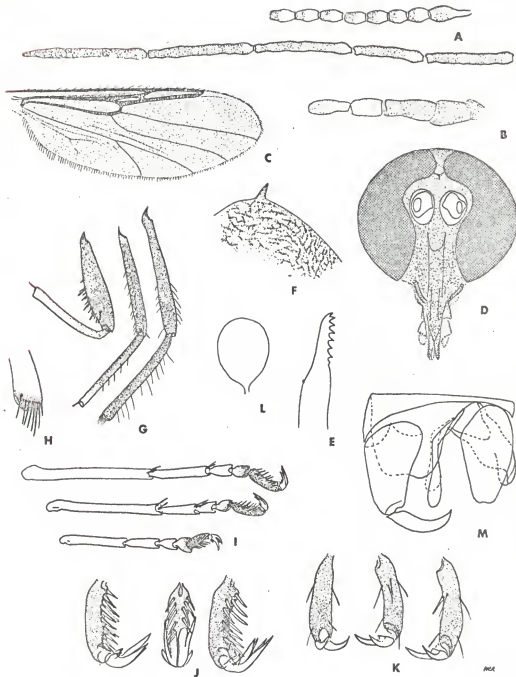


Figure 82.--Genus A: A, female antenna; B, female palpus; C, female wing; D, female head; E, mandible; F, anterior mesonotum; G, female legs; H, enlarged hind tibial comb; I, female tarsi; J, female fifth tarsomeres and claws; K, male fifth tarsomeres; L, female spermatheca; M, male genitalia.

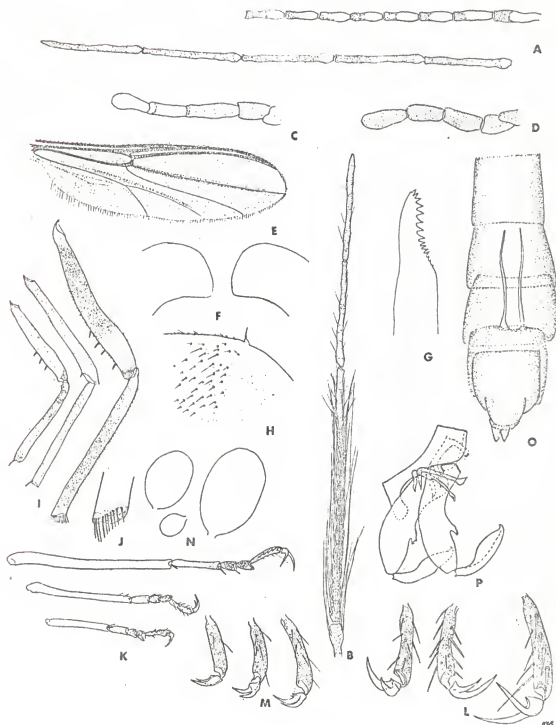


Figure 83.--Genus B: A, female antenna; B, male antenna; C, female palpus; D, male palpus; E, female wing; F, female eye separation; G, mandible; H, anterior mesonotum; I, female legs; J, enlarged hind tibial comb; K, female tarsi; L, female fifth tarsomeres and claws; M, male fifth tarsomeres; N, female spermathecae; O, female abdomen; P, male genitalia.

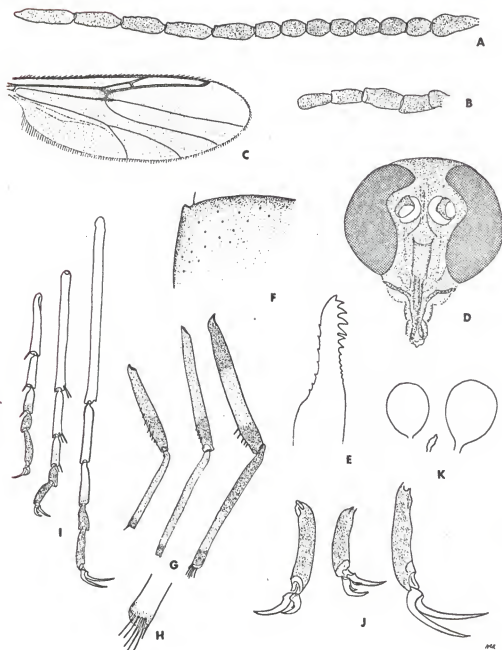


Figure 84.--Genus C: A, female antenna; B, female palpus; C, female wing; D, female head; E, mandible; F, anterior mesonotum; G, female legs; H, enlarged hind tibial comb; I, female tarsi; J, female fifth tarsomeres and claws; K, female spermathecae.

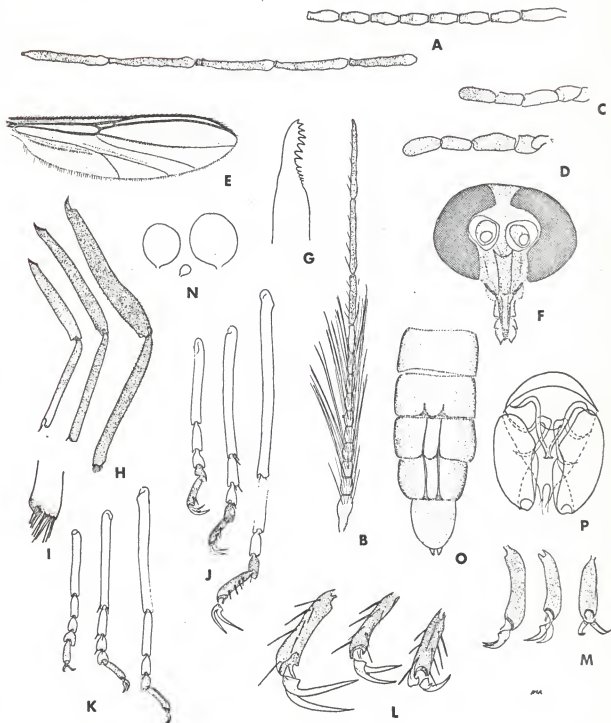


Figure 85.--Genus *D* sp. 1: A, female antenna; B, male antenna; C, female palpus; D, male palpus; E, female wing; F, female head; G, mandible; H, female legs; I, enlarged hind tibial comb; J, female tarsi; K, male tarsi; L, female fifth tarsomeres and claws; M, male fifth tarsomeres; N, female spermathecae; O, female abdomen; P, male genitalia.

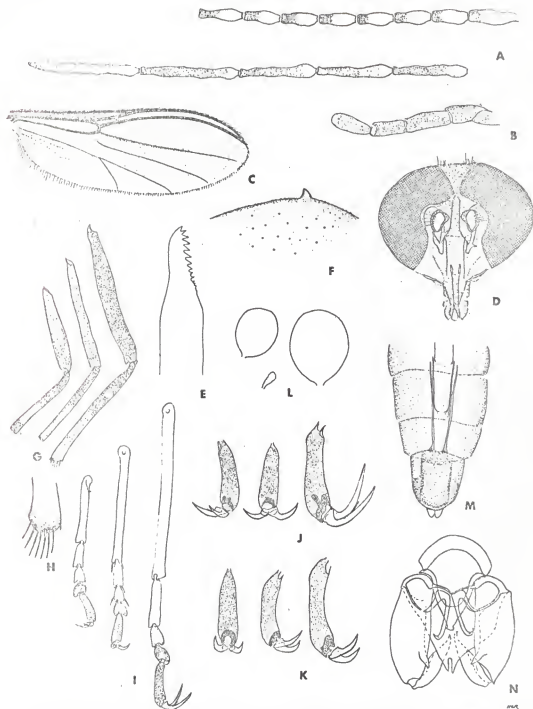


Figure 86.--Genus D sp. 2: A, female antenna; B, female palpus; C, female wing; D, female head; E, mandible; F, anterior mesonotum; G, female legs; H, enlarged hind tibial comb; I, female tarsi; J, female fifth tarsomeres and claws; K, male fifth tarsomeres; L, female spermathecae; M, female abdomen; N, male genitalia.

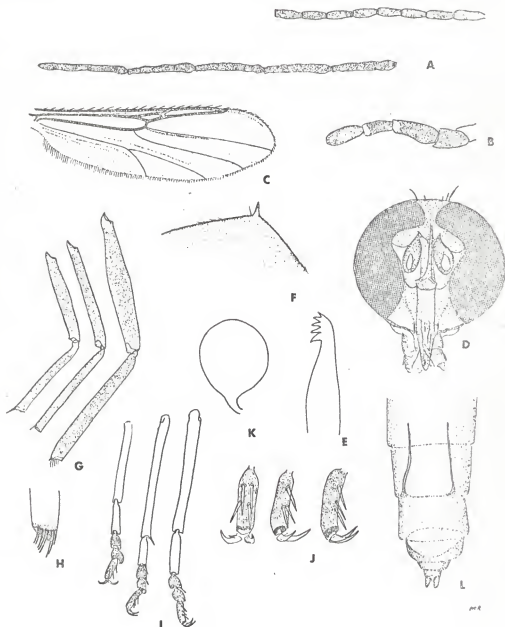


Figure 87.--Genus E: A, female antenna; B, female palpus; C, female wing; D, female head; E, mandible; F, anterior mesonotum; G, female legs; H, enlarged hind tibial comb; I, female tarsi; J, female fifth tarsomeres and claws; K, female spermatheca; L, female abdomen.

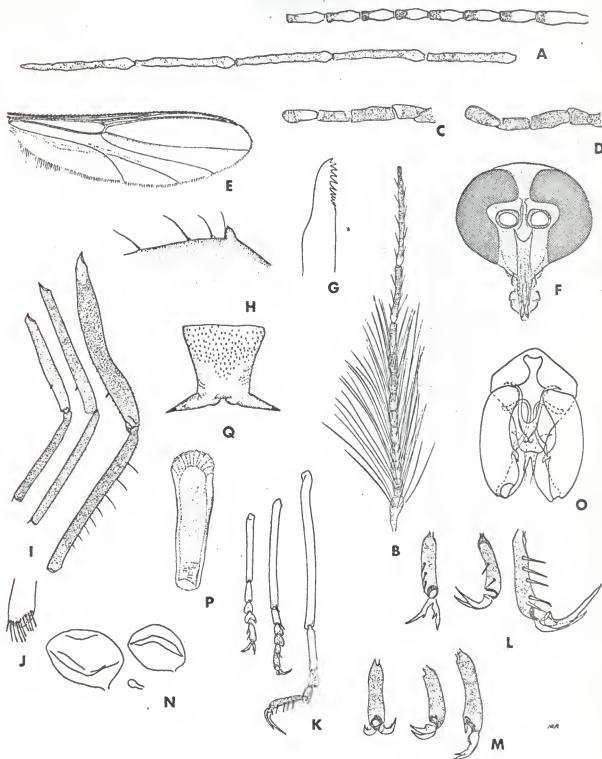


Figure 88.--Genus *F* sp. 1: A, female antenna; B, male antenna; C, female palpus; D, male palpus; E, female wing; F, female head; G, mandible; H, anterior mesonotum; I, female legs; J, enlarged hind tibial comb; K, female tarsi; L, female fifth tarsomeres and claws; M, male fifth tarsomeres; N, female spermathecae; O, male genitalia; P, pupal respiratory organ; Q, pupal anal segment.



Figure 89.--Genus F sp. 2: A, female antenna; B, male antenna; C, female palpus; D, male palpus; E, female wing; F, female eye separation; G, mandible; H, female legs; I, enlarged hind tibial comb; J, female tarsi; K, female fifth tarsomeres and claws; L, male fifth tarsomeres; M, female spermathecae; N, male genitalia; O, pupal respiratory organ; P, pupal abdominal segment; Q, pupal anal segment.

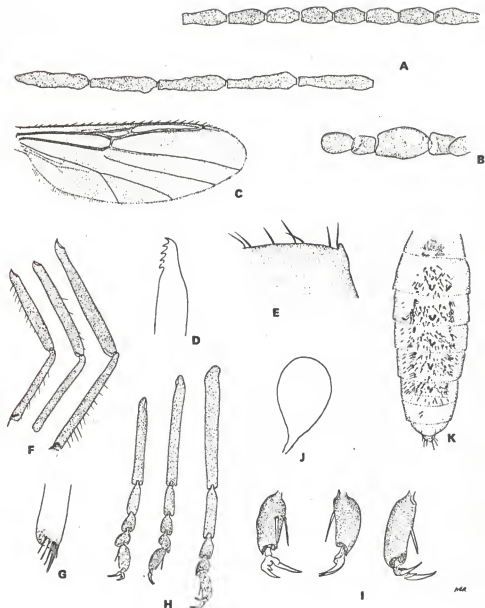


Figure 90.--Genus G; A, female antenna; B, female palpus; C, female wing; D, mandible; E, anterior mesonotum; F, female legs; G, enlarged hind tibial comb; H, female tarsi; I, female fifth tarsomeres and claws; J, female spermatheca; K, female abdomen.

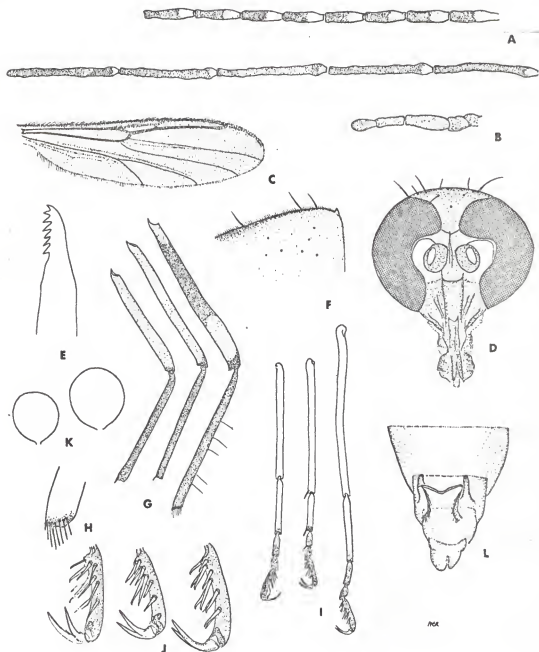


Figure 91.--Genus H: A, female antenna; B, female palpus; C, female wing; D, female head; E, mandible; F, anterior mesonotum; G, female legs; H, enlarged hind tibial comb; I, female tarsi; J, female fifth tarsomeres and claws; K, female spermathecae; L, female abdomen.

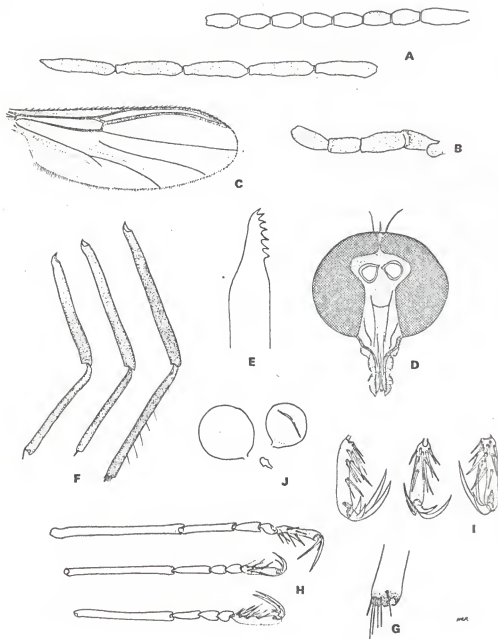


Figure 92.--Genus J: A, female antenna; B, female palpus; C, female wing; D, female head; E, mandible; F, female legs; G, enlarged hind tibial comb; H, female tarsi; I, female fifth tarsomeres and claws; J, female spermathecae.

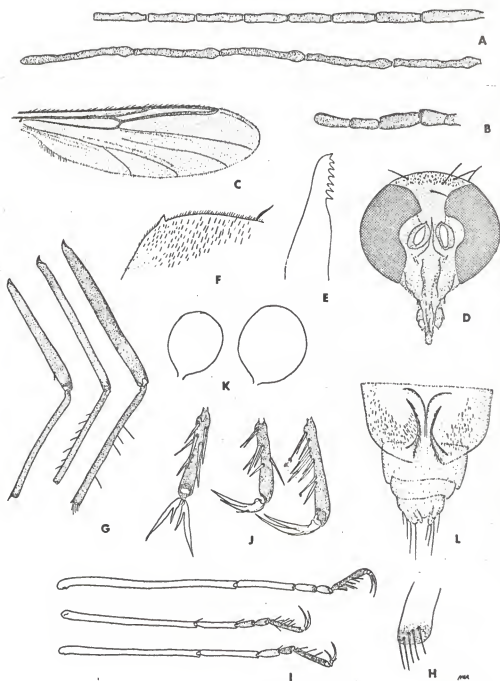


Figure 93.--Genus K: A, female antenna; B, female palpus; C, female wing; D, female head; E, mandible; F, anterior mesonotum; G, female legs; H, enlarged hind tibial comb; I, female tarsi; J, female fifth tarsomeres and claws; K, female spermathecae; L, female abdomen.

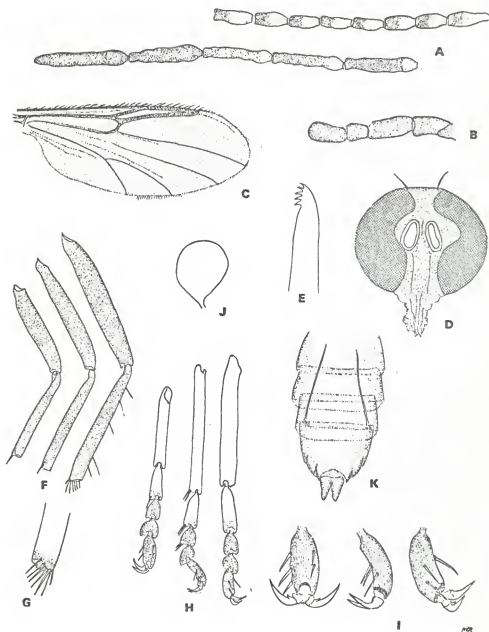


Figure 94.--Genus L: A, female antenna; B, female palpus; C, female wing; D, female head; E, mandible; F, female legs; G, enlarged hind tibial comb; H, female tarsi; I, female fifth tarsomeres and claws; J, female spermatheca; K, female abdomen.

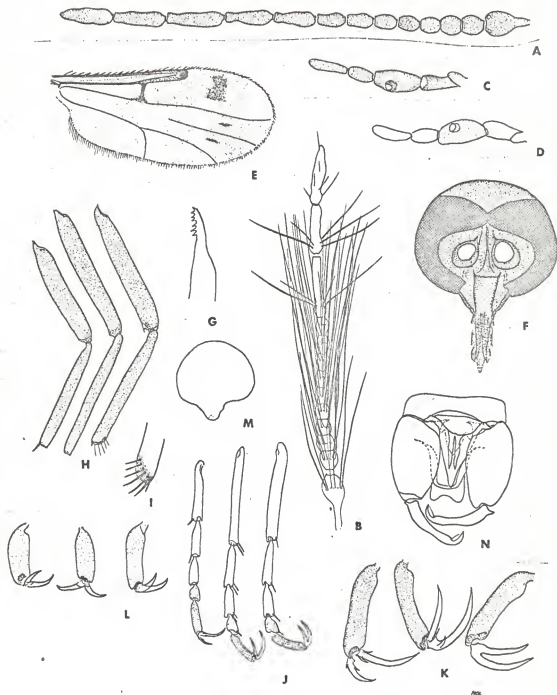


Figure 95.--Genus M: A, female antenna; B, male antenna; C, female palpus; D, male palpus; E, female wing; F, female head; G, mandible; H, female legs; I, enlarged hind tibial comb; J, female tarsi; K, female fifth tarsomeres and claws; L, male fifth tarsomeres; M, female spermatheca; N, male genitalia.

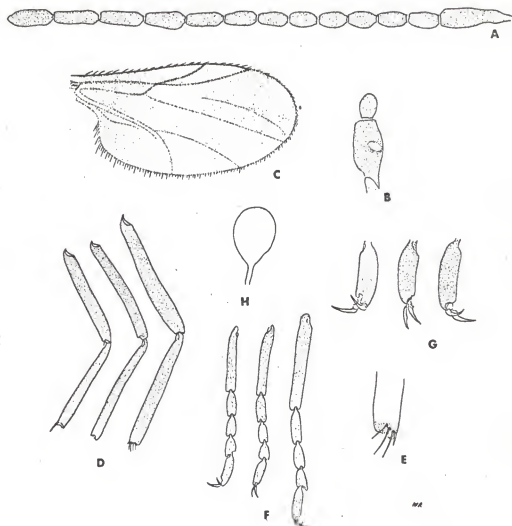


Figure 96.--Genus N: A, female antenna; B, female palpus; C, female wing; D, female legs; E, enlarged hind tibial comb; F, female tarsi; G, female fifth tarsomeres and claws; H, female spermatheca.

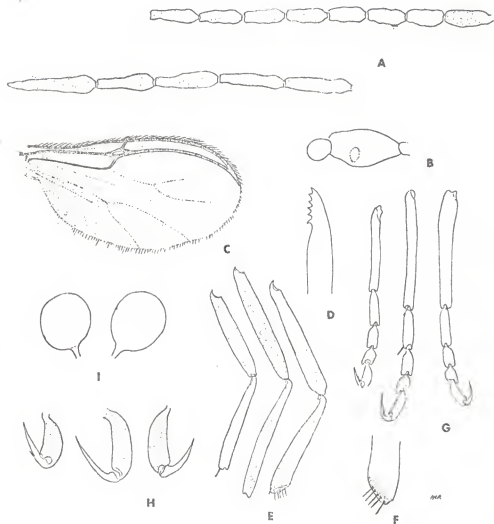


Figure 97.--Genus O: A, female antenna; B, female palpus; C, female wing; D, mandible; E, female legs; F, enlarged hind tibial comb; G, female tarsi; H, female fifth tarsomeres and claws; I, female spermathecae.

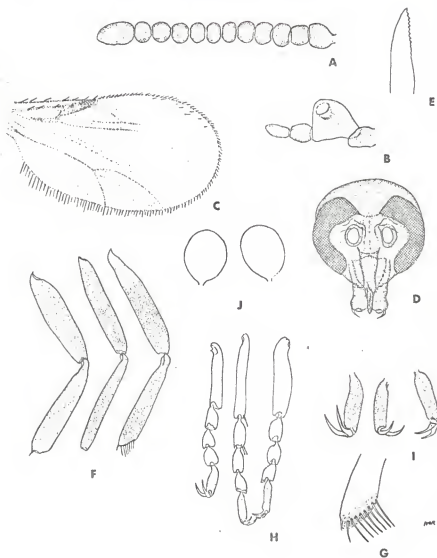


Figure 98.--Genus P: A, female antenna; B, female palpus; C, female wing; D, female head; E, mandible; F, female legs; G, enlarged hind tibial comb; H, female tarsi; I, female fifth tarsomeres and claws; J, female spermathecae.

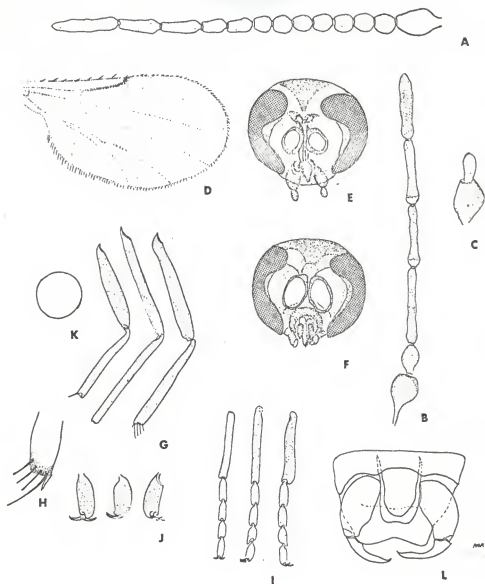


Figure 99.--Genus Q: A, female antenna; B, male antenna; C, female palpus; D, female wing; E, female head; F, male head; G, female legs; H, enlarged hind tibial comb; I, female tarsi; J, female fifth tarsomeres and claws; K, female spermatheca; L, male genitalia.

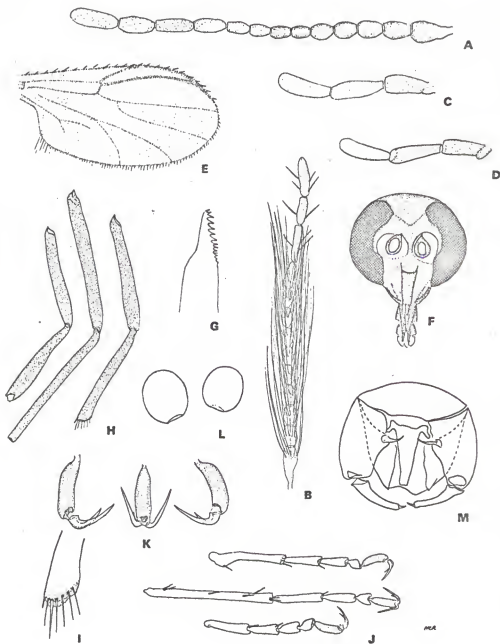


Figure 100.--Genus R: A, female antenna; B, male antenna; C, female palpus; D, male palpus; E, female wing; F, female head; G, mandible; H, female legs; I, enlarged hind tibial comb; J, female tarsi; K, female fifth tarsomeres and claws; L, female spermathecae; M, male genitalia

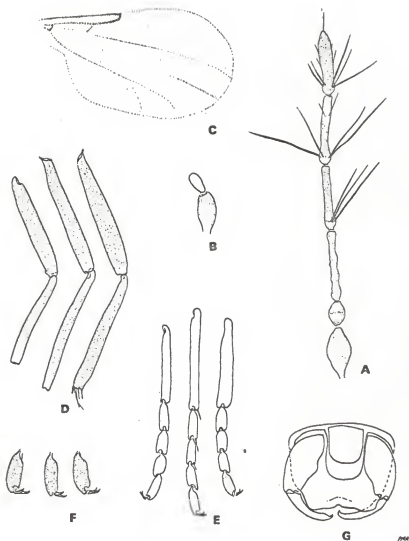


Figure 101.--Genus S: A, male antenna; B, male palpus; C, male wing; D, male legs; E, male tarsi; F, male fifth tarsomeres and claws; G, male genitalia.

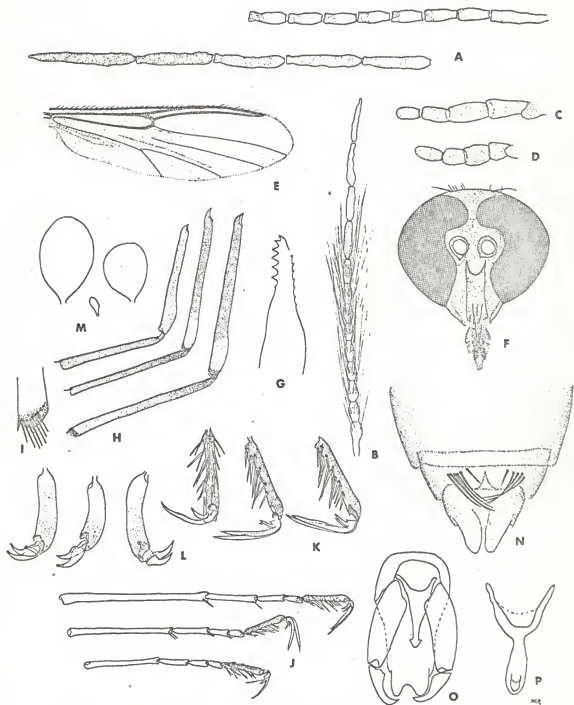


Figure 102.--Genus T: A, female antenna; B, male antenna; C, female palpus; D, male palpus; E, female wing; F, female head; G, mandible; H, female legs; I, enlarged hind tibial comb; J, female tarsi; K, female fifth tarsomeres and claws; L, male fifth tarsomeres; M, female spermathecae; N, female abdomen; O, male genitalia; P, male paramere.

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BIOGRAPHICAL SKETCH

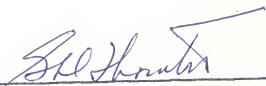
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This dissertation was prepared under the direction of the chairman of the candidate's supervisory committee and has been approved by all members of that committee. It was submitted to the Dean of the College of Agriculture and to the Graduate Council, and was approved as partial fulfillment of the requirements for the degree of Doctor of Philosophy.

March, 1969


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